

Work-Related Skull Fractures in Michigan:
Fourth Report
(January 2018 – December 2019)

and

Work-Related Hospitalized Intracranial Injuries
with Workers' Compensation as the Expected
Payer: Second Report
(January 2018 – December 2019)

MICHIGAN STATE
UNIVERSITY

Department of Medicine
Division of Occupational and Environmental Medicine
909 Wilson Rd, Room 118
West Fee Hall
East Lansing, MI 48824

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Prepared by:

Joanna Kica, MPA
Kenneth Rosenman, MD

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SKULL FRACTURES

EXECUTIVE SUMMARY

Michigan State University's Occupational and Environmental Medicine Division compiles data on work-related skull fractures in the state of Michigan. This is the fourth report on occupational skull fractures in Michigan; it covers the years 2018 and 2019. These are the key findings:

- Work-related skull fractures were identified through multiple reporting sources.
 - There were 480 work-related skull fractures, including six deaths, in 2018.
 - There were 472 work-related skull fractures, including 11 deaths, in 2019.
- For 2018 through 2019, the Federal reporting system that relies on employer reporting, estimated only 160 work-related skull fractures in Michigan or 16.8% of the 952 work-related skull fractures reported in Michigan's multi-source reporting system.
- The most common type of medical encounter was an emergency room visit (57.6%).
- Seventy-nine percent of all work-related skull fractures were among men.
- Eighty-five percent of all work-related skull fractures were among whites.
- Facial bones were the most common location of the fracture (72.8%).
- The most common type of work-related skull fracture was a depressed skull fracture (broken bone pushed inward) (37.6%).
- Thirty-six percent of individuals lost consciousness due to the head injury.
- Two NORA Sector Groups – Services (except Public Safety) and Construction accounted for almost half (48.9%) of all work-related skull fractures.
- A "fall" was the predominant cause of injury in the Construction NORA Sector Group (62.7%). "Struck by" injuries were the leading cause of injuries in the Manufacturing NORA Sector Group (37.8%).
- Workers' Compensation was the expected payer for only 58.9% of the 788 cases that were identified in the hospital/ED records.
- The Michigan OSHA program completed inspections at 27 worksites identified by the skull fracture surveillance system. MIOSHA issued 44 violations and assessed \$143,250 in fines.

BACKGROUND

This is the fourth report on occupational skull fractures in Michigan. The report is based on data for 2018 and 2019. A skull fracture, which is a crack or break in the cranial (skull) bones, is a small percentage of all traumatic brain injuries (TBI). TBI encompasses a larger category of skull injuries and includes concussions and other conditions without a bone fracture.

Occupational skull fractures are a preventable cause of work-related injury and are among the most severe that can occur in a workplace. A skull fracture is a “traumatic injury resulting from exposure to mechanical energy. Mechanical energy injuries include acceleration and deceleration injuries, blunt trauma, and penetrating wound injuries.”^{1,2} Health professionals and health facilities are required to report individuals with all injuries, including skull fractures, regardless of cause when requested by the Michigan Department of Health and Human Services (MDHHS) or a local health department. The Michigan work-related skull fracture surveillance system, based on mandatory reporting, allows the state to identify causes of work-related skull fractures, target interventions to reduce future skull fractures and evaluate the effectiveness of these interventions.

Nationally, the Bureau of Labor Statistics (BLS), the official source of work-related injury statistics, reported 4,820 work-related skull fractures (excluding fractures to eye(s)) in 2018 (incidence rate of four skull fractures per 100,000 full-time workers), and 4,830 in 2019 (incidence rate of 4/100,000).^{3,4} The BLS estimates are based on employer reporting. The BLS estimate includes private industry and state and local government workers but not the self-employed. In Michigan, BLS estimated 50 work-related skull fractures in 2018, and 110 in 2019. This corresponds to a rate in Michigan of one and three work-related skull fractures per 100,000 full-time workers, respectively.^{5,6}

Michigan State University’s Occupational and Environmental Medicine Division operates the skull fracture surveillance system as the bona fide agent for the State. Once a work-related diagnosis is confirmed and a case meets designated criteria, the Michigan Occupational Safety and Health Administration determines whether to conduct a workplace investigation.

DATA SOURCES AND METHODS

There were three reporting sources of work-related skull fractures in Michigan:

- Hospitals/Emergency Departments/hospital outpatients
- Workers' Disability Compensation Agency (WDCA)
- Michigan Fatality Assessment and Control Evaluation (MIFACE)⁷

All 134 acute care hospitals, including Veterans' Administration Hospitals in Michigan, were required to report work-related skull fractures. Medical records are used to identify work-related skull fractures treated at a hospital/emergency department (ED) or as an outpatient visit at a hospital-based clinic. Cases to be reported were defined as any individual aged 16 years or older receiving medical treatment at a Michigan hospital/ED/hospital outpatient for whom:

(a) ICD-10-CM diagnostic code⁸ was assigned

- S02 – Fracture of skull and face bones, and

(b) the incident was recorded as having occurred at work.

The Michigan WDCA provided access to a database of paid claims for wage replacement due to lost work time. Individuals are eligible for wage replacement when they have had at least seven consecutive days away from work. Cases identified using Michigan's WDCA data were defined as an individual who was in the lost work time wage replacement database with an accepted claim for a fracture ("Nature of Injury" code) to one of the following "Parts of Body": Brain; Cheek/Chin/Jaw; Concussion; Ear(s), unspecified; Ear(s), external; Ear(s), internal; Face, multiple parts; Face, not elsewhere specified; Face, unspecified; Forehead; Head, multiple; Head, unspecified; Mandible; Nasal passages; Nose; Scalp; Sinus; Skull; or Teeth.

Cases identified through the MIFACE program were identified as individuals whose underlying cause of death was from a skull fracture. If the fatality was identified using hospital medical records, it was linked to records in the MIFACE database regardless of the cause of death.

Information from the hospital/ED medical reports and MIFACE reports on each case were abstracted, including reporting source(s), type of medical care (hospital, ED, outpatient), hospital name, type of visit, date of admission and discharge, patient demographics, city and county of residence, source of payment, employer information (name, address, NAICS code⁹), injury date, cause of injury, type of fracture, loss of consciousness. Once these skull fracture data were entered into a Microsoft Access database, records were manually linked to records in the WDCA database. Matches were identified using individual's first and last name, date of birth and date of injury. Finally, WDCA cases meeting the work-related skull fracture case definition that did not match with any of the other data sources (i.e., where WDCA was the sole source of the case report) were identified. Information from Workers' Compensation on matched cases and new cases were added to the database. Duplicates identified by more than one reporting source were eliminated, after abstracting all information from every data source. NAICS codes were converted to a NORA Sector Group.¹⁰

Individuals whose workplaces could not be identified in their medical records and met the criteria for a possible MIOSHA inspection were contacted by telephone to obtain employer information. The criteria for a possible MIOSHA inspection were: 1) the individual had to be hospitalized, treated in an emergency department or as an outpatient at a hospital in 2018 or 2019, 2) the injury was not caused by a motor vehicle event or an assault, 3) the injury did not occur to a self-employed individual or an individual employed by an employer not covered by Michigan OSHA (i.e., federal, railroad, merchant marine, dock or mine employees), 4) the circumstances of the injury suggested there was an ongoing hazard and 5) the skull fracture occurred in the last six months.

For cases inspected by MIOSHA, additional information was obtained about the results of the inspection including inspection date, whether the hazard causing the skull fracture was present at the time of the inspection, number of violations, and total fines assessed.

Data analysis was performed using queries conducted in Microsoft Access. The NIOSH Employment Labor Force Query System, which uses BLS Current Population Survey (CPS) data, provided the estimated number of employed Michigan residents by age group, gender and industry for 2018 through 2019.¹¹

The BLS Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the 2018 and 2019 BLS estimates and incidence rates of the number of nonfatal occupational injuries and illnesses involving days away from work by selected worker and case characteristics and nature of condition for both private and public ownerships.³⁻⁶ For 2018 through 2019, code 111XXX (Fractures) and code 183XXX (Fractures and other injuries) was used. “Head” was selected as the part of body affected to generate the number of fractures to the head. Workers 16 years and older were selected.

RESULTS

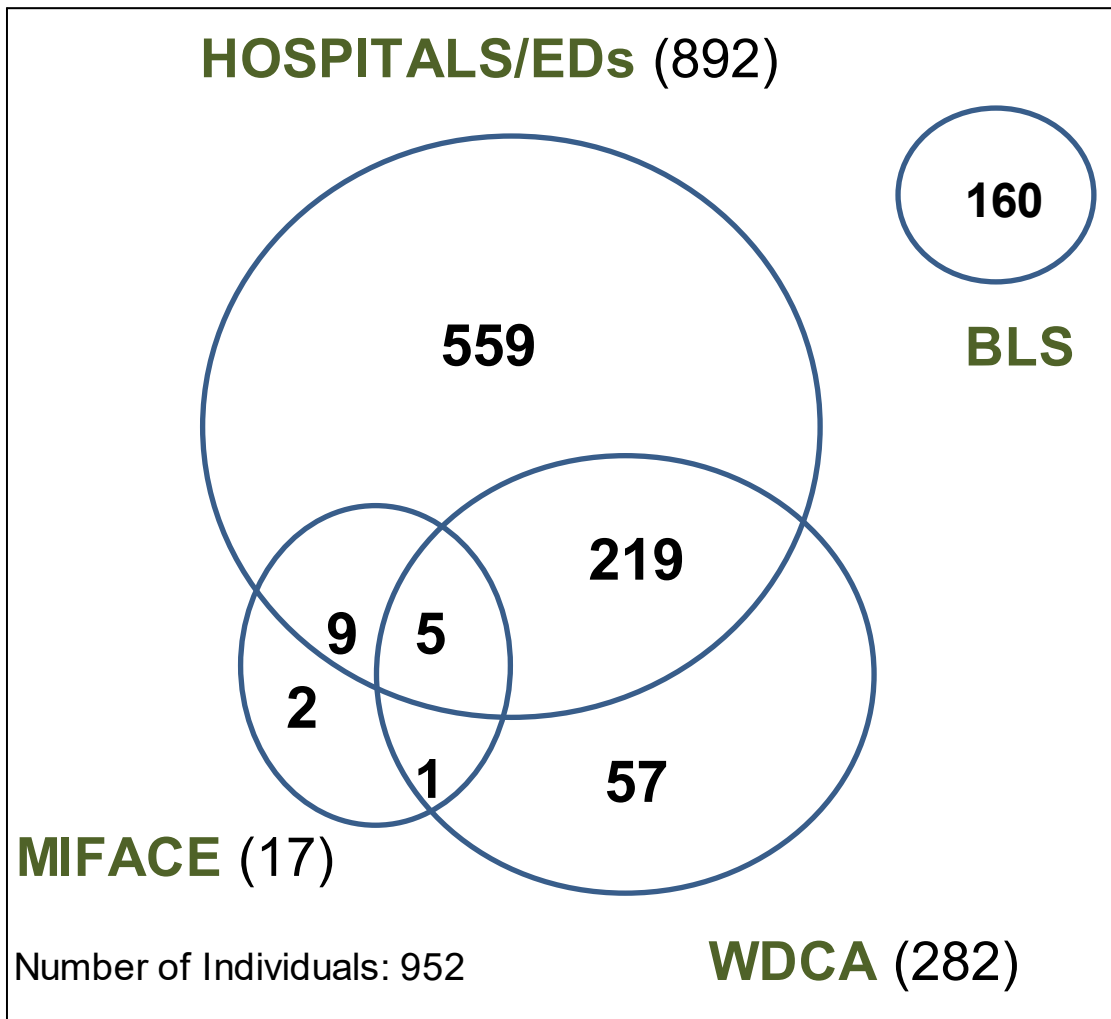
In 2018, 480 individuals and in 2019, 472 individuals had a work-related skull fracture.

2018 - 2019 combined: There were 952 work-related skull fractures in 952 individuals.

Reporting Sources

The number of 2018-2019 work-related skull fractures in Michigan by the reporting source and a comparison with the number estimated by BLS is shown in Figure 1.

Figure 1. Reporting Sources of Work-Related Skull Fractures, Michigan 2018 - 2019



*There is presumably overlap between the 160 estimates of the BLS and the Michigan reporting sources (HDC, MIFACE and WDCA) but BLS does not allow access to their data thus matching to assess the degree of overlap was not possible.

2018 - 2019 Reporting Sources

Hospital/ED reports identified 892 skull fractures, WDCA 282 skull fractures, and MIFACE 15 fatalities. Hospital/ED reports matched with 220 WDCA reports and 8 MIFACE reports. Another five skull fractures were identified by all the reporting sources. Fifty-seven skull fractures were identified by the WDCA data source only. One skull fracture was identified by MIFACE and WDCA. Two fatalities were identified by the MIFACE source only. Because of confidentiality restrictions of the BLS, no attempt was made to match the Michigan data set with the BLS data set.

There were 282 WDCA cases identified as work-related skull fractures. One hundred and fourteen were identified because they had been classified as a fracture to one of the following parts of body: Brain; Cheek/Chin/Jaw; Concussion; Ear(s), external; Ear(s), internal; Ear(s), unspecified; Face, multiple parts; Face, not elsewhere specified; Face, unspecified; Forehead; Head, multiple; Head, unspecified; Mandible; Nasal passages; Nose; Scalp; Sinus; Skull; or Teeth. Of the 114 records, 56 matched with hospital/ED records and one matched with both hospital/ED records and MIFACE records, and 57 did not match with either hospital/ED or MIFACE records. The other 168 were included because they matched with names from one or more of the other data sources, although they had an injury description in the WDCA database as something other than “Fracture of skull”. The descriptions in WDCA for these 168 were: 37 “Multiple Injuries”, 33 “Fracture” (other than skull), 27 “Unclassified”, 23 “Crush/Contusion”, 21 “Cut/Laceration”, 11 “Concussion”, 10 “Strains/Sprains”, 4 “Other Injury/NEC”, 1 “Dislocation”, and 1 “Abrasion/Scratch”. Matches were made based on the employee’s name, date of birth, date of injury, employee’s zip code and employer.

An emergency room visit was the most common type of medical encounter, 548 (57.6%), followed by hospitalization in 299 (31.4%) cases. The type of medical care that workers received was not available for 57 WDCA cases and three fatalities (Table 1).

Table 1. Work-Related Skull Fractures by the Type of Medical Encounter, Michigan 2018 - 2019

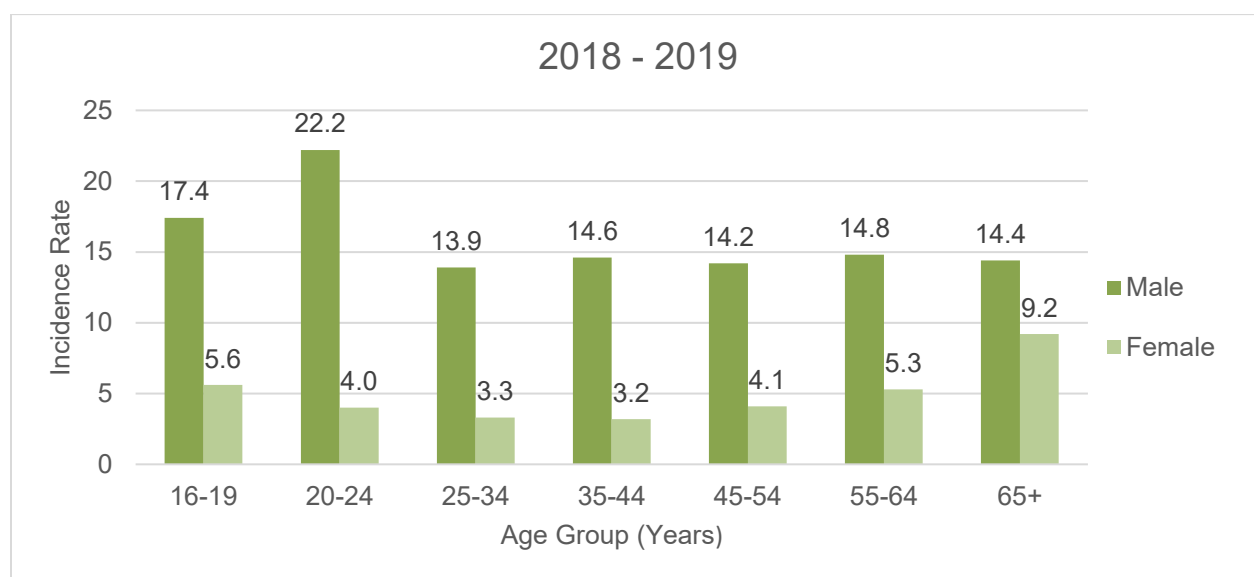
Medical Encounter Type	2018 - 2019	
	Number	Percent
Hospitalization	299	31.4
Emergency Department	548	57.6
Outpatient	45	4.7
Death Certificate	3	0.3
Unknown	57	6.0
Total	952	100.0

Characteristics of Injured Workers

Age and Gender

Age was not available for four workers. Gender was available for all workers with work-related skull fractures. The age of the injured workers ranged from 16 to 95 years. The average age was 42 and median age was 42. Seven hundred and fifty-seven (79.5%) of all work-related skull fractures were among men. Figure 2 displays skull fracture rates by age group and gender. Among males, rates were highest for workers in the 20-24 age group with 22.2/100,000. For females, the age group with the highest rate of skull fractures was 65+ (9.2/100,000).

Figure 2. Work-Related Skull Fracture Rates by Age Group and Gender, Michigan 2018 - 2019*



*Data Sources: Number of work-related skull fractures – Michigan hospital/ED medical records, MIFACE and WDCA; Total number of workers by age group and sex – NIOSH Employment Labor Force Query System (BLS CPS).¹¹

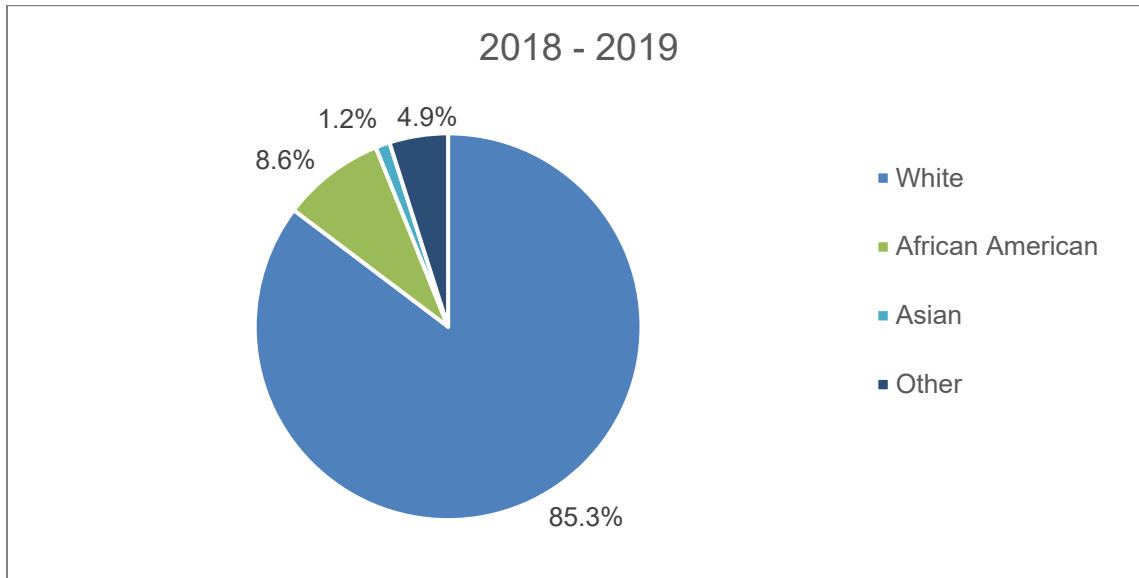
Note: Rates are the number of workers sustaining a skull fracture per 100,000 workers.

Race and Ethnicity

The race of workers with work-related skull fractures was available for 490 individuals (51.5%) (Figure 3). Four hundred and eighteen (85.3%) were white, 42 (8.6%) were African American, six (1.2%) were Asian, and 24 (4.9%) were Other.

Information on ethnicity was provided for 324 (34.0%) individuals. Of the 324 individuals, 28 (8.6%) were of Hispanic origin and 296 (91.4%) individuals were not of Hispanic origin.

Figure 3. Race Distribution of Work-Related Skull Fractures, Michigan 2018 - 2019*



*Race information available for 490 (51.5%) individuals

Part of Skull Injured

The discharge summaries of the medical records and emergency department histories and physicals were reviewed to determine the part of skull fractured. The WDCA database did not classify injuries by ICD-10 codes but did specify the part of the skull injured, which was then recoded into the ICD-9 codes.

Fractures of facial bones occurred most often (72.8%), followed by fractures of the base of the skull (10.8%) (Table 2).

Table 2. Work-Related Skull Fractures by Part of Skull, Michigan 2018 - 2019

Part of Skull Injured	2018 - 2019	
	Number	Percent
Vault	22	2.3
Base	103	10.8
Face Bones	693	72.8
Other and Unqualified	73	7.7
Multiple	61	6.4
Total	952	100.0

Type of Skull Fracture

The severity of a skull fracture depends on its location and the damage done to the bone and surrounding tissue. While there are many types of fractures of the cranial (skull) bones, the main categories are:

- Linear (or Hairline) Skull Fracture – a break in a cranial bone resembling a thin line, without splintering or depression of bone,
- Depressed Skull Fracture – a break in the cranial bone with depression of the bone in toward the brain,
- Compound Skull Fracture – a break in, or loss of, skin and splintering of the bone,
- Displaced Skull Fracture – a break of the bone into two or more parts and displacement of the bone so that the two ends are not lined up straight,
- Comminuted Skull Fracture – is a fracture in which the bone is in multiple fragments.

The type of skull fracture was only available for 354 (37.2%) of the fractures. There were 133 (37.6%) depressed skull fractures, 103 (29.1%) linear fractures, 88 (24.9%) compound fractures, 21 (5.9%) comminuted fractures, and 9 (2.5%) displaced fractures (Table 3).

Table 3. Work-Related Skull Fractures by Type of Fracture, Michigan 2018 - 2019*

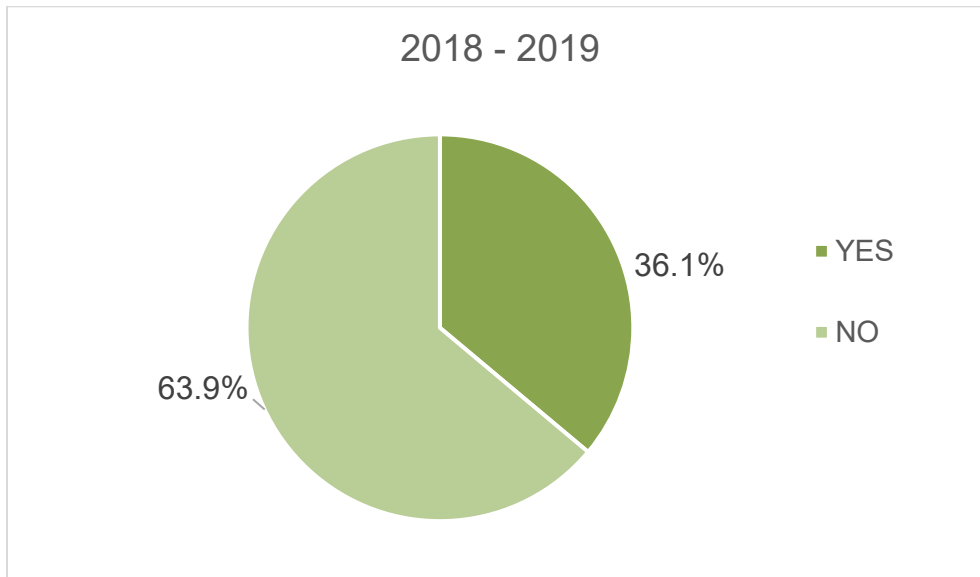
Type of Fracture	2018 - 2019	
	Number	Percent
Depressed	133	37.6
Linear	103	29.1
Compound	88	24.9
Comminuted	21	5.9
Displaced	9	2.5
Total	354	100.0

*Type of skull fracture was not specified for 598 (62.8%) cases

Loss of Consciousness

Whether an individual lost consciousness was described for 674 (70.8%) cases (Figure 4).

Figure 4. Work-Related Skull Fractures by Loss of Consciousness Status, Michigan 2018 - 2019*



*For 278 (29.2%) cases it was unknown if individuals lost consciousness due to the injury to head

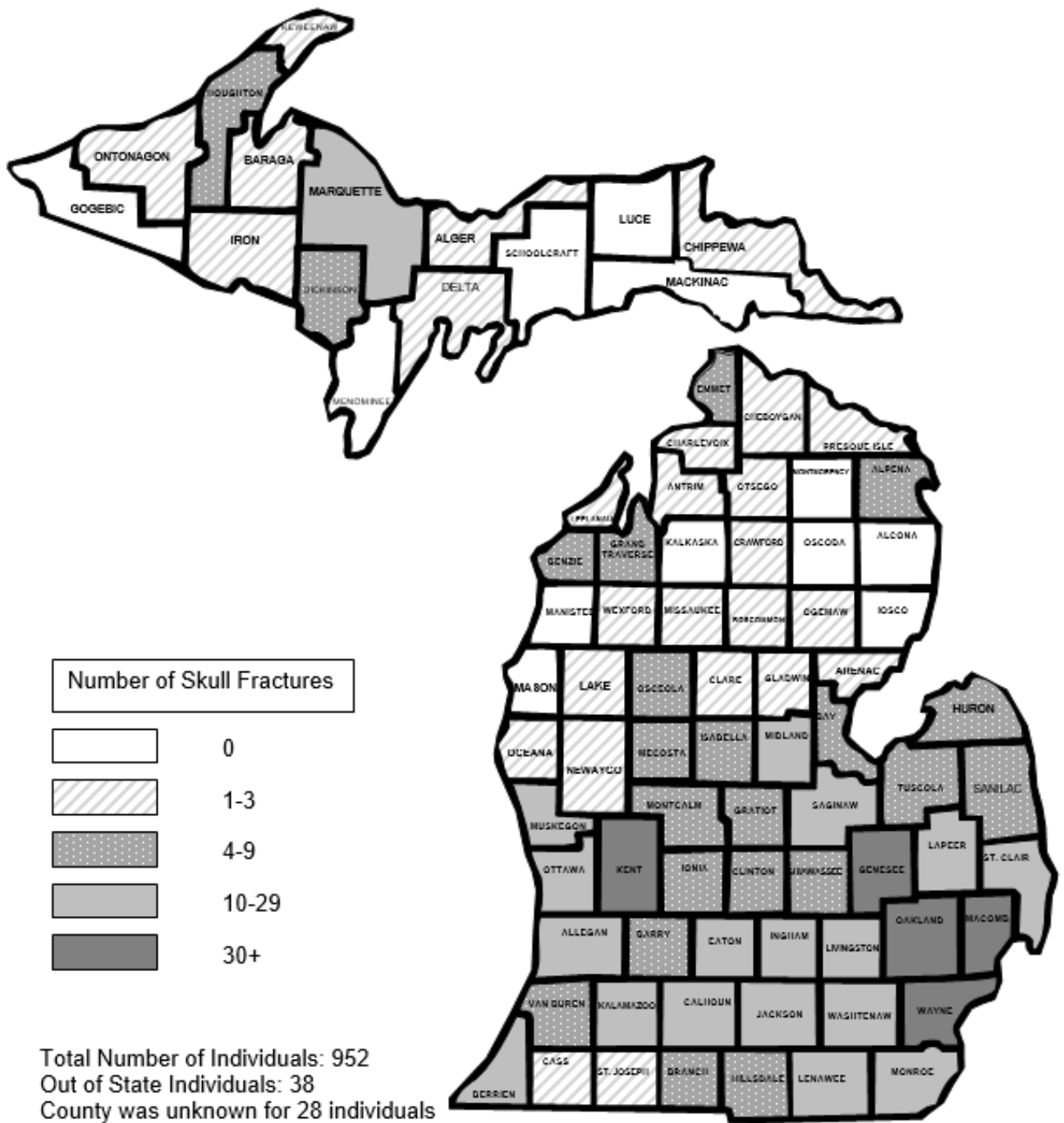
County of Residence

There were 886 Michigan residents for whom the county of residence was known (Table 4 and Figure 5). There were 38 out-of-state residents. County of residence was unknown for 28 Michigan residents. It should be noted that the county of residence would not necessarily be the same county where the individual was injured. Wayne County had the highest number of residents with a work-related skull fracture with 149 (15.7%) cases, followed by 78 (8.2%) cases in Macomb County and 74 (7.8%) cases in Oakland County.

Table 4. Work-Related Skull Fractures by County of Residence, Michigan 2018 - 2019

2018 - 2019			2018 - 2019		
County	Number	Percent	County	Number	Percent
Alcona	0	-	Leelanau	3	0.3
Alger	1	0.1	Lenawee	14	1.5
Allegan	12	1.3	Livingston	10	1.1
Alpena	6	0.6	Luce	0	-
Antrim	3	0.3	Mackinac	0	-
Arenac	2	0.2	Macomb	78	8.2
Baraga	1	0.1	Manistee	0	-
Barry	6	0.6	Marquette	10	1.1
Bay	9	0.9	Mason	0	0.1
Benzie	4	0.4	Mecosta	6	0.6
Berrien	17	1.8	Menominee	0	-
Branch	5	0.5	Midland	10	1.1
Calhoun	23	2.4	Missaukee	1	0.1
Cass	2	0.2	Monroe	13	1.4
Charlevoix	3	0.3	Montcalm	9	0.9
Cheboygan	1	0.1	Montmorency	0	-
Chippewa	2	0.2	Muskegon	20	2.1
Clare	3	0.3	Newaygo	1	0.1
Clinton	8	0.8	Oakland	74	7.8
Crawford	1	0.1	Oceana	2	0.2
Delta	1	0.1	Ogemaw	3	0.3
Dickinson	7	0.7	Ontonagon	1	0.1
Eaton	13	1.4	Osceola	5	0.5
Emmet	5	0.5	Oscoda	0	-
Genesee	40	4.2	Otsego	3	0.3
Gladwin	3	0.3	Ottawa	17	1.8
Gogebic	0	-	Presque Isle	1	0.1
Grand Traverse	9	0.9	Roscommon	1	0.1
Gratiot	6	0.6	Saginaw	23	2.4
Hillsdale	6	0.6	Saint Clair	19	2.0
Houghton	7	0.7	Saint Joseph	2	0.2
Huron	5	0.5	Sanilac	9	0.9
Ingham	21	2.2	Schoolcraft	0	-
Ionia	6	0.6	Shiawassee	9	0.9
Iosco	0	-	Tuscola	8	0.8
Iron	2	0.2	Van Buren	9	0.9
Isabella	6	0.6	Washtenaw	20	2.1
Jackson	28	2.9	Wayne	149	15.7
Kalamazoo	28	2.9	Wexford	3	0.3
Kalkaska	0	-	Out of State	38	4.0
Kent	35	3.7	Unknown	28	2.9
Keweenaw	1	0.1			
Lake	3	0.3	Total	952	100.0
Lapeer	11	1.2			

Figure 5 Work-Related Skull Fractures by County of Residence, Michigan 2018 - 2019



Cause of Injury

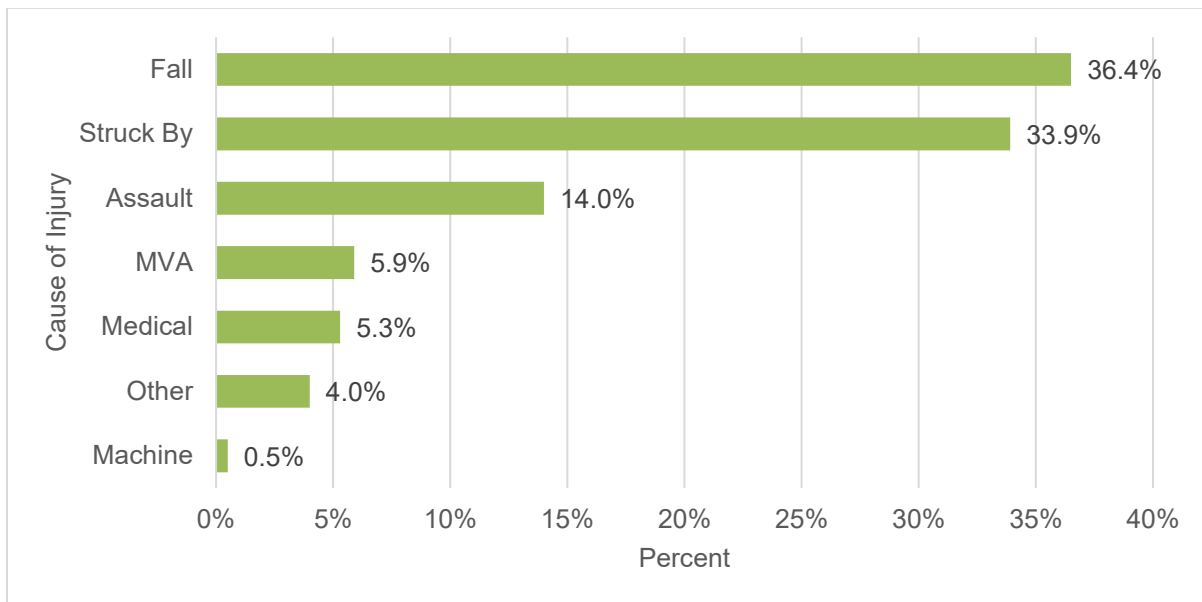
Causes of skull fractures were:

- Fall – a fall can be to the same level (i.e., trip while walking on the floor) or to a lower level (e.g., from a ladder, working on a roof or scaffolding).
- Struck By – Falling objects, (e.g., while being beneath cranes that move loads or scaffolds); flying objects, (e.g., when power tools may cause objects to become airborne); struck by moving machinery; hit by an animal.
- Motor Vehicle Crash (MVC) – a vehicle collides with another vehicle, pedestrian, animal, or some stationary obstruction, e.g., a tree or utility pole.
- Assault – A person is intentionally hit in the head (e.g., robbery, teacher by a student, patient in a health care setting).
- Machine – Malfunction of a machine or equipment (e.g., being “caught” inside a sanding machine, grinder).
- Medical Condition – medical conditions such as syncope or fainting, which lead to a transient loss of consciousness and postural tone.
- Other – Includes different types of injury sources that did not fall into the six specific categories (e.g., turning around and walking into an industrial hook, suicide).

The cause of work-related skull fractures was specified for 870 (91.4%) cases (Figure 6). It was unknown for 82 cases. The predominant cause of a skull fracture was a fall in 317 (36.4%) cases, followed by a struck by incident in 295 (33.9%) cases, an assault in 122 (14.0%) cases, a motor vehicle crash in 51 (5.9%) cases, medical condition in 46 (5.3%) cases, “other” in 35 (4.0%) cases, and a machine in 4 (0.5%) cases. Skull fractures due to fall and struck by incidents accounted for over two-thirds of all skull fractures. When the NORA Sector was specified, the Construction industry sector had the highest percentage of skull fractures due to a fall with 84 (62.7%) cases, followed by the Wholesale and Retail Trade industry sector with 32 (37.6%) cases (Table 6). Among

hospitalized individuals, fall was the cause of the skull fracture for 141 (47.2%) cases, followed by struck by for 62 (20.7%) cases. Of seventeen fatalities between 2018 and 2019, nine were caused by a fall, three from being struck by an object, three due to a motor vehicle crash, and two from a self-inflicted gunshot wound.

Figure 6. Work-Related Skull Fracture by Cause of Injury, Michigan 2018 - 2019*



*Cause of injury was specified for 870 (91.4%) cases.

NORA Sector Groups

For 821- (86.2%) cases, including 60 self-employed individuals, there was sufficient information to determine their National Occupational Research Agenda (NORA) Sector Group classification (Table 5). The Services (except Public Safety) Sector Group had the highest number of work-related skull fractures with 268 (32.6%) cases, followed by the Construction Sector Group with 134 (16.3%) cases and then the Manufacturing Sector Group with 119 (14.5%) cases. The Oil and Gas Extraction Sector Group had the highest rate of skull fractures with 506.8/100,000 workers, followed by the Agriculture, Forestry and Fishing (except Wildland Firefighting) Sector Group with 60.8/100,000 workers.

Table 5. Work-Related Skull Fractures by Industry, Michigan 2018 - 2019*

NORA Sector Group	NAICS Code	Number	Percent	Rate
Agriculture, Forestry & Fishing (except Wildland Firefighting)	11	61	7.4	60.8
Construction	23	134	16.3	26.4
Healthcare & Social Assistance	62, 54194, 81291	58	7.1	4.4
Manufacturing	31-33	119	14.5	6.6
Mining (except Oil & Gas Services)	21	3	0.4	36.9
Oil & Gas Extraction	211, 213111, 213112	6	0.7	506.8
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	20	2.4	3.9
Services (except Public Safety)	51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92	268	32.6	7.4
Transportation, Warehousing & Utilities	48-49, 22	67	8.2	15.5
Wholesale & Retail Trade	42, 44-45	85	10.4	7.4
Total		821	100.0	8.6

*Sufficient information for sector groups classification was available for 821 (86.1%) of cases.

¹Rates are the number of workers sustaining a skull fracture per 100,000 workers. Number of workers by NORA Group Sectors used to calculate rates: NIOSH Employment Labor Force Query System.

Top Five NORA Sector Groups by Cause of Injury

Table 6 illustrates the top five NORA Sector Groups by cause of injury. “Struck by” was the predominant cause of skull fracture within the Manufacturing (37.8%) and the Transportation, Warehousing and Utilities (31.3%) Sector Groups. “Fall” was the predominant cause of a skull fracture in the Construction (62.7%), Wholesale and Retail Trade (37.6%) and the Manufacturing (31.1%) Sector Groups.

Table 6. Top Five NORA Sector Groups by Cause of Injury, Michigan 2018 - 2019

NORA Sector Group	Struck By	Fall	Machine	Assault	MVC	Other	Medical Condition	Unkn	TOTAL
Services (except Public Safety)	77	73	1	43	17	12	13	32	268
Construction	29	84	0	0	4	4	5	8	134
Manufacturing	45	37	1	6	2	4	8	16	119
Wholesale & Retail Trade	21	32	0	10	5	3	6	8	85
Transportation, Warehousing & Utilities	21	14	0	8	11	2	2	9	67

Source of Payment

Workers' Compensation was the expected payer in 464 (58.9%) of the 788 work-related skull fractures for which source of payment was in the medical record (Table 7). For 104 skull fractures payment source could not be identified. Of the 324 cases for which Workers' Compensation was not listed as a payment source in medical records, 27 were matched to a case in the WDCA database. Of those 27 cases, eight were classified as a skull fracture and 19 had an injury description in the WDCA database as something other than "skull fracture".

Table 7. Work-Related Skull Fractures by Payment Source, Michigan 2018 – 2019

Expected Source of Payment	2018 - 2019	
	Number	Percent
Workers' Compensation	464	58.9
Commercial Insurance	162 ¹	20.6
Medicare/Medicaid	120 ²	15.2
Self-Pay	38 ³	4.8
Other Government	4	0.5
Total	788	100.0

Data Source: Michigan hospital/ED medical records.

*Payment source was unknown for 104 (11.7%) cases

¹Includes 26 self-employed workers, ²Includes 28 self-employed workers,

³Includes 4 self-employed workers

MIOSHA Inspections

MIOSHA inspected 27 workplaces where skull fractures had occurred, including eight workplaces where a fatal injury occurred. Table 8 illustrates the distribution of violations and penalties assessed by the NORA Sector Group type of the 27 inspected workplaces. In 18 of the 27 (66.7%) companies, the hazard that caused the skull fracture had not been corrected at the time of the inspection, which was conducted three to six months after the skull fracture occurred.

Table 8. Workplaces Inspected by MIOSHA: Violations and Penalties Assessed by Industry, Michigan 2018 - 2019

NORA Sector Group	# of Enforcement Inspections	# of Companies Cited	# of Violations	# of Recom.	Total Penalties Assessed
Construction	11	8	21	0	\$73,450
Manufacturing	7	5	14	0	\$28,800
Services (except Public Safety)	3	2	2	1	\$7,700
Agriculture	2	1	2	0	\$14,000
Healthcare & Social Assistance	2	1	1	0	\$4,800
Wholesale & Retail Trade	1	1	3	0	\$9,500
Transportation, Warehousing & Utilities	1	1	1	0	\$5,000
Total	27*	19**	44	1	\$143,250

*Includes 8 inspections of fatal injuries.

**18 (94.7%) of these companies had not corrected the hazard at the time of the inspection.

Examples of Work-Related Skull-Fracture MIOSHA Enforcement Inspections

➤ *Logging*

A male truck mechanic in his mid-fifties, employed at a logging firm, died when he was struck by a steel lever arm while working on a log trailer. The decedent was servicing the axle raising mechanism of a log trailer. The lever arm responsible for lifting and lowering the axle malfunctioned/broke at the pivot point. The force applied to the lever arm was supplied by an expanding compressed air diaphragm. The decedent was positioned underneath the air diaphragm when the lever broke and sent the rounded metal base of the air diaphragm downward with tremendous force. The decedent was pinned to the ground. He was immediately extricated by his coworkers but never regained consciousness. MIOSHA found two serious violations: "The procedures shall clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including, but not limited to, the following: A. A specific statement of the intended use of the procedure; B. Specific procedural steps for shutting down, isolating, blocking, and securing machines or equipment to control hazardous energy, C. Specific procedural steps for the placement, removal and transfer of lockout devices or tagout devices and the responsibility for them, and D. Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures. (The employer had not developed a procedure that clearly and specifically outlined the scope, purpose, and techniques to be utilized for the control of hazardous energy when employees were troubleshooting maintenance services to be rendered. On March 21, 2019, an

employee was fatally injured while working on a logging trailer in the maintenance shop. The employee was in the process of troubleshooting issues with the rear lift axle on the back end of the logging trailer while the truck and trailer were energized.); In situations in which lockout or tagout devices must be temporarily removed from the energy isolating device and the machine or equipment energized to test or position the machine, equipment or component thereof, the following sequence of actions shall be followed: (i) Clear the machine or equipment of tools and materials in accordance with paragraph (e)(1) of this section, (ii) Remove employees from the machine or equipment area in accordance with paragraph (e)(2) of this section, (iii) Remove the lockout or tagout devices as specified in paragraph (e)(3) of this section, (iv) Energize and proceed with testing or positioning; (v) Deenergize all systems and reapply energy control measures in accordance with paragraph (d) of this section to continue the servicing and/or maintenance. (The employee was not safely positioned when the lifting beam broke and contacted the employee.)”

➤ *Ready-Mix Concrete Manufacturing*

A male in his mid-forties was hospitalized for eight days after falling 15 feet from a drum wash platform of a truck he was spraying. MIOSHA found two serious and one other-than-serious violations: “The employer must ensure walking-working surfaces are inspected, regularly and as necessary, and maintained in a safe condition. (There were no regular inspections completed to ensure that the drum wash platform on truck #7 was maintained in a safe condition prior to the employee accident on September 24, 2018.); Except as provided elsewhere in § 1910.28 or by other subparts of 29 CFR 1910, the employer must ensure each employee on a walking-working surface 4 feet (1.2 m) or more above a lower level is protected from falling by: (i) Guardrail systems; (ii) Safety net systems; or (iii) Personal fall protection systems, such as personal fall arrest, travel restraint, or positioning systems. (There was no guardrail, safety net, or personal fall protection system provided to the employee that fell from the drum wash platform of truck #7.); Within 24 hours after the inpatient hospitalization of 1 or more employees or an employee’s amputation or an employee’s loss of an eye, as a result of a work-related incident, you must report the inpatient hospitalization, amputation, or loss of an eye to MIOSHA. (There was no report to MIOSHA of the inpatient hospitalization of an employee that fell from an elevation on September 24, 2018.)” The company had not corrected the hazard at the time of the inspection.

➤ *Specialty Trade Contractors*

A male in his early fifties was hospitalized for seven days after he was struck in the head by a steel spreader bar. The injured employee and his coworker were engaged in installing a new belt into a Red River live-bottom asphalt trailer. A steel spreader bar was attached to an alloy steel chain on one side and to the belt with random steel bolts on the other side. The injured employee was standing at the rear of the trailer inspecting the belt when it became stuck and signaled the skid

steer operator to continue pulling. The bolt on the left side suddenly snapped, causing the spreader bar to swing to the right, striking the employee in the face and head resulting in several fractures. MIOSHA found one serious and three other-than-serious violations: “An employer shall furnish to each employee, employment and a place of employment that is free from recognized hazards that are causing, or are likely to cause, death or serious physical harm to the employee. (The employer did not furnish to each employee, employment, and a place of employment, which was free from recognized hazards that were causing, or were likely to cause, death or serious physical harm to the employee. Employees were not protected from struck by hazards posed by a flying steel spreader bar an alloy steel chain. Among other methods, one feasible and acceptable abatement method to correct this hazard is to ensure all employees are removed from the potential trajectory of flying steel chains and spreader bars while under tension. Also, ensure that adequate attachment means are utilized to attach the spreader bar to the belts being replaced or removed.); Hospitalizations, amputations, and losses of an eye. Within 24 hours after the inpatient hospitalization of one or more employees or an employee’s amputation or an employee’s loss of an eye, as a result of a work-related incident, you must report the inpatient hospitalization, amputation, or loss of an eye to MIOSHA. (Traumatic face, skull, and neck injuries suffered by an employee, which required inpatient hospitalization, was not reported to MISOAH within 24 hours.); You must use MIOSHA 300, 300-A, and 301 forms, or equivalent forms, and shall complete the forms in the detail required by the forms and the instructions contained in the forms for the purpose of recording recordable injuries and illnesses. The MIOSHA 300 form is called the log of work-related injuries and illnesses. (The MIOSHA 300 logs for years 2017 and 2018 were not maintained. One amputation was not recorded in 2017, and one recordable injury requiring hospitalization was not recorded in 2018.); An employer shall assess the workplace to determine if hazards are present, or are likely to be present, that necessitate the use of personal protective equipment. (There was an incomplete personal protective equipment hazard assessment performed. The personal protective equipment assessment did not address potential hazards to the face and eyes from flying metal debris throughout the plant during vehicle servicing duties, or hazards to the body, eyes, and head during construction activities.)

HOSPITALIZED INTRACRANIAL INJURIES WITH WORKERS' COMPENSATION AS THE EXPECTED PAYER

EXECUTIVE SUMMARY

This is the second report on occupational hospitalized intracranial injuries (with no fractures of the skull) with Workers' Compensation as the expected payer in Michigan; it covers the years 2018 and 2019 and is based on hospital medical records only. These are the key findings:

- Work-related intracranial injuries were identified through hospital medical records.
 - There were 32 work-related intracranial injuries in 2018.
 - There were 34 work-related intracranial injuries in 2019.
- There were an additional 13 (one case in 2018, and 12 cases in 2019) hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer that had a skull fracture as an underlying cause of injury and therefore were included in the 2018-2019 skull fractures dataset and not in this intracranial injuries report.
- There were 583 (268 cases in 2018, and 315 cases in 2019) WDCA cases in 2018-2019 identified as concussions (brain, cerebral). Of the 583 WDCA cases, nine matched with hospital medical reports and 574 did not match with hospital reports. There were an additional 29 WDCA cases that matched with names from medical records, although they had an injury description in the WDCA database as something other than a "concussion." WDCA data does not include information on whether an individual concussion was hospitalized, therefore this dataset was not included in the total number of work-related hospitalized intracranial injuries.

- MIFACE Program identified 43 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). Three fatalities of the 43 were identified by hospital medical records as hospitalized cases with Workers' Compensation as the expected payer and the cases were included in the total.
- For 2018 and 2019, the Federal reporting system that relies on employer reporting, estimated 1,250 work-related intracranial injuries; these are all reported intracranial injuries, irrespective of employees' medical encounter type.
- Seventy-seven percent of all work-related intracranial injuries were among men.
- Seventy-four percent of all work-related intracranial injuries were among whites.
- "Fall" was the predominant cause of intracranial injuries and accounted for over half of injuries (53.0%).
- Three NORA Sector Groups – Services (except Public Safety), Manufacturing and Wholesale and Retail Trade Sector Groups accounted for over half (61.8%) of all work-related intracranial injuries.
- The Michigan OSHA program completed inspections at two worksites identified by the intracranial surveillance system. MIOSHA issued six violations and assessed \$61,000 in fines.

BACKGROUND

Beginning in 2014, we expanded the work-related skull fracture surveillance to include individuals hospitalized overnight with work-related intracranial injuries, including bleeds and concussions, with Workers' Compensation as the expected payer (Table 10). This is the second report on work-related hospitalized intracranial injuries with Workers' Compensation as the expected payer in Michigan. The report is based on data for 2018 through 2019.

Nationally, the Bureau of Labor Statistics (BLS), the official source of work-related injury statistics, reported 22,130 work-related intracranial injuries in 2018 (incidence rate of 19 workers with intracranial injuries per 100,000 full-time workers), and in 2019 (incidence rate of 20/100,000).¹²⁻¹³ The BLS estimates are based on employer reporting. The BLS estimate includes private industry and state and local government workers but not the self-employed. For Michigan, the BLS reported 620 work-related intracranial injuries in 2018, and 630 in 2019. This corresponds to a rate of 18 work-related intracranial injuries per 100,000 full-time workers, respectively.¹⁴⁻¹⁵

DATA SOURCES AND METHODS

There were three reporting sources of work-related hospitalized intracranial injuries with Workers' Compensation as the expected payer in Michigan:

- Hospitals/Emergency Departments/hospital outpatients
- Workers' Disability Compensation Agency (WDCA)
- Michigan Fatality Assessment and Control Evaluation (MIFACE)¹¹

All 134 acute care hospitals, including Veterans' Administration Hospitals in Michigan, were required to report work-related intracranial injuries with workers' compensation as the expected payer and an overnight hospital stay. Cases to be reported were defined as any individual receiving medical treatment at a Michigan hospital for whom:

(a) ICD-10-CM diagnostic code¹³ was assigned (Table 9)

- S04 – Optic nerve and pathways,
- S06 – Intracranial injury,
- S09.8 – Other specified injuries of head,
- S09.9 – Unspecified injury to face and head,

(b) the incident was recorded as having occurred at work, and

(c) Workers’ Compensation was the expected payer.

The Michigan WDCA provided access to a database of claims for wage replacement due to lost work time. Individuals are eligible for wage replacement when they have had at least seven consecutive days away from work. Cases identified using Michigan’s Workers’ Compensation system were defined as an individual who was in the lost work time wage replacement database with an accepted claim for a “Concussion (brain, cerebral)” (“Nature of Injury” code) to one of the following “Parts of Body” code: Brain; Head, multiple; Head, unspecified; or Skull.

Cases identified through the MIFACE program were identified as individuals whose underlying cause of death were from an intracranial injury. If the fatality was identified using hospital medical records, it was linked to records in the MIFACE database regardless of the cause of death.

Table 9. Work-Related Hospitalized Intracranial Injury ICD-10 Diagnosis Codes

Intracranial Injury ICD-10 Code	
S04.0	Optic Nerve and Pathways
S06	Intracranial Injury
S09.8	Other Specified Injuries of Head
S09.9	Unspecified Injury to Face and Head

Information from the hospital medical reports were abstracted, including type of medical care (hospital, ED, outpatient), hospital name, date of admission and discharge, patient

demographics, city and county of residence, employer information (name, address, NAICS¹⁴ code), self-employed status, injury date, cause of injury, ICD-9/ICD-10 code. Once these hospitalized intracranial injury data were entered into a Microsoft Access database, records were manually linked to records in the WDCA database. Matches were identified using individual's first and last name, date of birth and date of injury. Finally, WDCA cases meeting the work-related intracranial injury case definition that did not match with any of the other data sources (i.e., where WDCA was the sole source of the case report) were identified. Information from Workers' Compensation on matched cases were added to the database. NAICS codes were converted to a NORA Sector Group.¹⁵

Individuals whose workplaces could not be identified in the records and met the criteria for a MIOSHA inspection were contacted by telephone to obtain employer information. The criteria for a MIOSHA inspection were: 1) the individual had to be hospitalized in 2018 or 2019, 2) the injury was not caused by a motor vehicle event or an assault, 3) the injury did not occur to a self-employed individual or an individual employed by an employer not covered by Michigan OSHA (i.e. federal, railroad, merchant marine, dock or mine employees), 4) the circumstances of the injury suggested there was an ongoing hazard and 5) the intracranial injury occurred in the last six months.

For cases whose employers were inspected by MIOSHA, additional information was obtained about the results of the inspection, including inspection date, number of violations, whether the hazard causing the injury was corrected at the time of the inspection, and total fines assessed.

Data analysis was performed using queries conducted in Microsoft Access. The NIOSH Employment Labor Force Query System, which uses BLS Current Population Survey (CPS) data, provides the estimated number of employed Michigan residents by age group, gender, and industry for 2018 through 2019.¹⁶

The BLS Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the 2018 and 2019 BLS estimates and incidence rates of the number of nonfatal occupational injuries and illnesses involving days away from work by selected worker and case characteristics and nature of condition for both private and public

ownerships.³⁻¹⁰ For 2018 through 2019, code 16XXXX (Intracranial Injuries) was used. All workers, irrespective of their age, were selected.

RESULTS

In 2018, 32 individuals and, in 2019 34 individuals had a work-related intracranial injury reported from hospital for which Workers' Compensation was the expected payer.

2018 - 2019 combined: There were 66 work-related hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer.

There were an additional 13 (one case in 2018, and 12 cases in 2019) hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer that had a skull fracture as an underlying cause of injury and therefore were included in the 2018-2019 skull fractures dataset and not in the intracranial injuries dataset.

Reporting Sources

Michigan hospitals identified 66 work-related hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer.

There were 583 (268 cases in 2018, and 315 cases in 2019) WDCA cases identified as concussions (brain, cerebral) to one of the following parts of the body: Brain; Head, multiple; Head, unspecified; or Skull, and only nine matched with hospital records.

WDCA did not provide information on whether what type, if any, medical encounter injured individuals had received for their head injuries (e.g., emergency room visit, hospitalization, an outpatient visit at a hospital-based clinic, or individuals may have received medical care at an urgent care or at a primary physician's office). This dataset, except for matches described below, was not included in the total number of work-related hospitalized intracranial injuries. Of the 583 WDCA cases that were identified because they had been classified as concussion, nine matched with hospital reports and 574 did not match with hospital reports. There were additional 23 WDCA cases that matched with names from medical records, although they had an injury description in the WDCA database as something other than a "concussion". The descriptions in WDCA for these 23 were: 10 "Crush/Contusion", 5 "Multiple Injuries", 3 "Unclassified", 2 "Cut/Laceration",

2 “Strain/Sprain”, and 1 “Fracture”. Matches were made based on the employee’s name, date of birth, date of injury, employee’s zip code and employer.

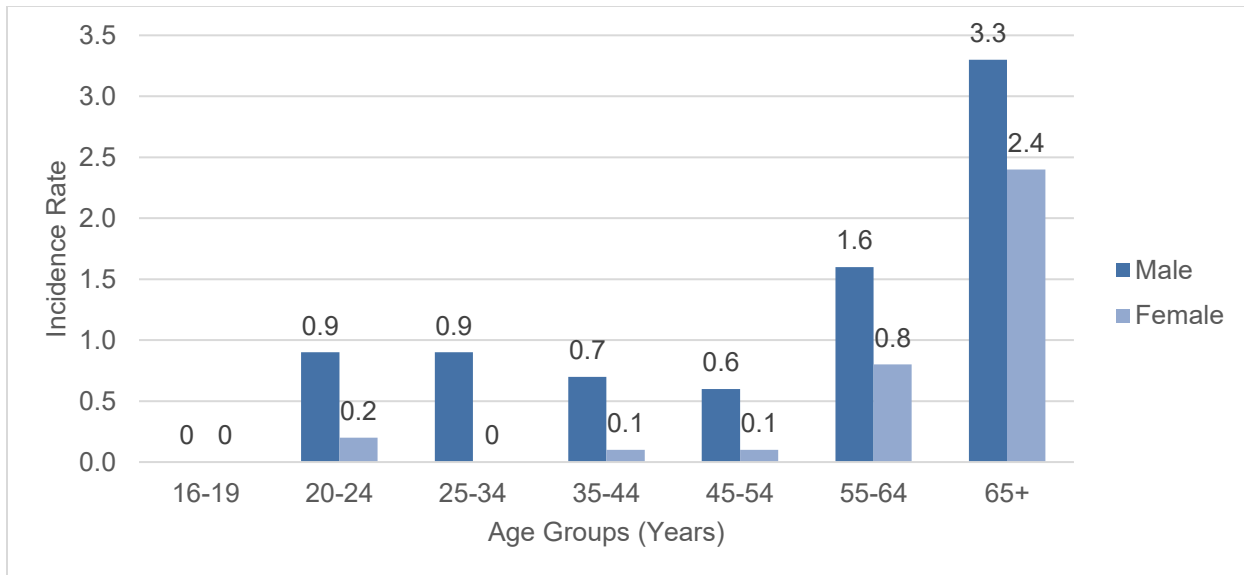
MIFACE Program identified 43 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). Three of the 43 fatalities were identified by hospital medical records as hospitalized cases with Workers’ Compensation as the expected payer.

Characteristics of injured workers

Age and Gender

Age and gender were available for all workers with work-related hospitalized intracranial injuries with Workers’ Compensation as the expected payer. The age of the injured workers ranged from 21 to 87 years. The average age was 52.1 and median age was 56.5. Fifty-one (77.3%) of all work-related intracranial injuries were among men. Figure 8 displays intracranial injuries rates by age group and gender. For both males and females, rates were highest for workers in the 65+ age group with 3.3/100,000 and 2.4/100,000 respectively.

Figure 8. Work-Related Hospitalized Intracranial Injury with Workers' Compensation as the Expected Payer Rates by Age Group and Gender, Michigan 2018 - 2019*



*Data Sources: Number of work-related hospitalized intracranial injuries with Workers' Compensation as the expected payer – Michigan hospital medical records; Total number of workers – NIOSH Employment Labor Force Query System

Race and Ethnicity

Among the workers for whom race was available (46; 70.0%), 34 (73.9%) were white, 8 (17.4%) were African American, 2 (4.3%) were Asian, and 2 (4.3%) were Other.

Of the 34 individuals where ethnicity was available; 3 (8.8%) were of Hispanic origin and 31 (91.2%) individuals were not of Hispanic origin.

County of Residence

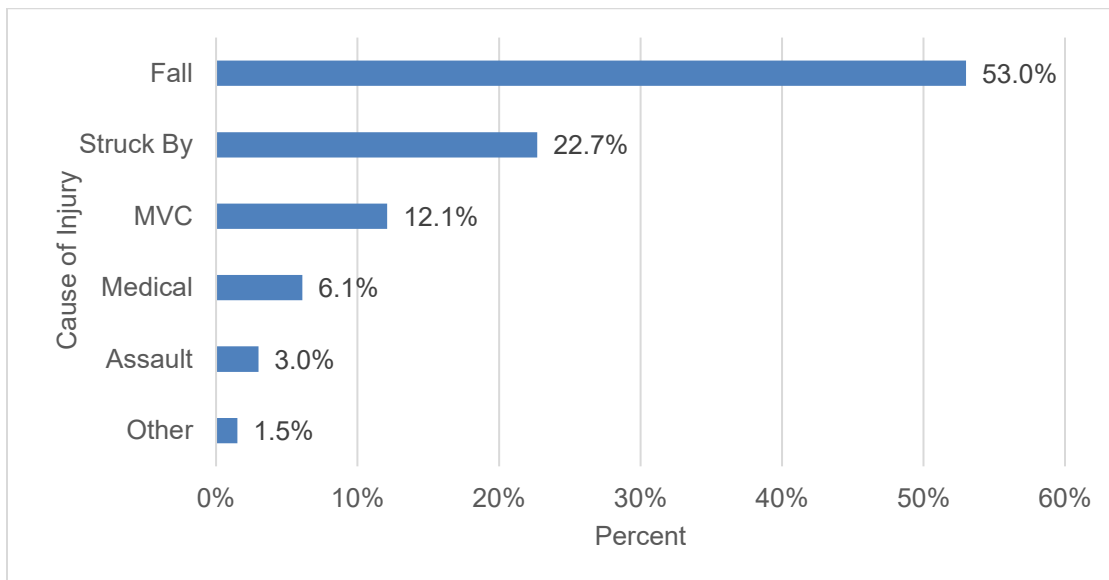
The county of residence was known for all Michigan residents. There was one out-of-state resident. It should be noted that the county of residence would not necessarily be the same county where the individual was injured. Wayne County had the highest number of residents with a work-related hospitalized intracranial injury with 14 (21.2%) cases, followed by seven (10.6%) cases in Macomb County and 6 (9.1%) cases in Mason County.

Cause of Injury

The categories of the causes of intracranial injuries were the same as in the skull fractures report (See page 15).

The cause of work-related hospitalized intracranial injuries with Workers' Compensation as the payer was specified for 65 (98.5%) cases (Figure 9). It was unknown for one case. The predominant cause of hospitalized intracranial injuries was a fall in 35 (53.0%) cases, followed by a struck by incident in 15 (22.7%) cases, motor vehicle crash in eight (12.1%) cases, an assault or medical condition (6.1%) cases, assault in two (3.0%) cases, and "other" in one (1.5%) case. Hospitalized intracranial injuries due to fall and struck by incidents accounted for over two-thirds of all hospitalized intracranial injuries. When the NORA Sector Group was specified, the Wholesale and Retail Trade industry sector had the highest percentage of intracranial injuries due to a fall with seven (87.5%) cases (Table11).

Figure 9. Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer by Cause, Michigan 2018 - 2019*



*Cause of work-related hospitalized intracranial injury was not specified for one (1.5%) individual.

NORA Sector Groups

For 55 (83.3%) cases there was sufficient information to determine their NORA Sector Group classification (Table 10). The Services (except Public Safety) Sector Group had the highest number of hospitalized intracranial injuries with 15 (27.3%) cases, followed by the Manufacturing Sector Group with 11 (20.0%) cases and then the Wholesale and Retail Trade with eight (14.5%) cases. The Transportation, Warehousing and Utilities Sector Group had the highest rate with 1.4/100,000 workers, followed by the Construction Sector Group with 1.0 /100,000 workers.

Table 10. Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the expected payer by Industry, Michigan 2018 - 2019*

NORA Sector Group	NAICS Code	Number	Percent	Rate¹
Agriculture, Forestry & Fishing (except Wildland Firefighting)	11	0	–	–
Construction	23	5	9.1	1.0
Healthcare & Social Assistance	62, 54194, 81291	6	10.9	0.5
Manufacturing	31-33	11	20.0	0.6
Mining (except Oil & Gas Services)	21	0	–	–
Oil & Gas Extraction	211, 213111, 213112	0	–	–
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	4	7.3	0.8
Services (except Public Safety)	51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92	15	27.3	0.4
Transportation, Warehousing & Utilities	48-49, 22	6	10.9	1.4
Wholesale & Retail Trade	42, 44-45	8	14.5	0.7
Total		55	100.0	0.6

*Sufficient information for sector groups classification was available for 55 (83.3%) cases.

¹Rates are the number of workers sustaining an intracranial injury per 100,000 workers. Number of workers by NORA Group Sectors used to calculate rates: NIOSH Employment Labor Force Query System.

Top Five NORA Sector Groups by Cause of Injury

Table 11 illustrates the top five NORA Sector Groups by cause of injury. Cause of injury was known for all cases in the top five NORA Sector Groups. “Fall” was the predominant cause of a hospitalized intracranial injury in the Wholesale and Retail Trade (87.5%), the Services (except Public Safety) (60%) and the Manufacturing (45.5%) Sector Groups. The Transportation, Warehousing and Utilities Sector Groups had the most motor vehicle crashes (66%).

Table 11. Top Five NORA Sector Groups of Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer by Industry, Michigan 2018 – 2019

NORA Sector Group	Struck By	Fall	Assault	MVC	Medical Condition	Total
Services (except Public Safety)	3	9	1	1	1	15
Manufacturing	4	5	0	0	2	11
Wholesale & Retail Trade	0	7	0	1	0	8
Healthcare & Social Assistance	3	2	1	0	0	6
Transportation, Warehousing & Utilities	0	2	0	4	1	6

MIOSHA Inspections

MIOSHA inspected two workplaces where a hospitalized intracranial injury had occurred. Both inspections were due to a fall, one fatal. Both incidents occurred in the manufacturing NORA sector group. MIOSHA cited both companies after finding six violations of the MIOSHA rules and assessed \$61,000 in penalties. Neither of the two companies receiving a citation had corrected the hazard that caused the intracranial injury.

Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer MIOSHA Enforcement Inspections

➤ *Perishable Prepared Food Manufacturing*

A male commissary worker in his early fifties was assembling breakfast and lunch sandwiches for retail distribution and was walking back towards his workstation with an empty bread tray in his hands when he lost his footing and fell backwards onto the cement floor. The employee struck the back of his head and lost consciousness. He regained consciousness after a few minutes and was transferred by EMS to a local hospital where he died seven days later from complications of a closed head injury and blunt force

injuries to the head. The refrigerated room had painted concrete floors that were known at times to accumulate condensation due to the humidity and environment. MIOSHA cited the company for three serious violations: “An employer shall not permit defective or damaged personal protective equipment to be used (An employee was permitted to wear damaged protective footwear in the commissary area. The rubber soles on the employee’s protective footwear were worn away to the point where the thread pattern was smooth and almost non-existent.); An employer shall provide training to teach employee who is required by these rules to use personal protective equipment. The training shall include all of the following: (a) When personal protective equipment is necessary, (b) What personal protective equipment is necessary, (c) How to properly don, doff, adjust, and wear the personal protective equipment, (d) The limitations of the personal protective equipment, (e) The proper care, maintenance, useful life, and disposal of the personal protective equipment. (There was no personal protective equipment training provided for the commissary production employees.); An employer shall verify that the required workplace hazard assessment has been performed through a written certification which identifies all of the following information: (a) The workplace evaluated, (b) The person certifying that the evaluation has been performed, (c) The date or dates of the personal protective hazard assessment, (d) The document of a certification of hazard assessment. (There was no written certification that a workplace hazard assessment had been completed for the production area.)

➤ *Motor Vehicle Brake System Manufacturing*

A male in his early fifties was repairing the magazine on the top of the CN-02 machine when his foot slipped back and he fell approximately 7 feet, striking his head on the machine as he fell. He sustained a concussion and was hospitalized for one day. MIOSHA found one repeat-serious violation and two other-than-serious violations: “Except as provided elsewhere in § 1910.28, the employer must ensure that each employee on a walking-working surface with an unprotected side or edge that is 4 feet (1.2m) or more above level is protected from falling by one or more if the following: (a) Guardrail systems, (b) Safety net systems, or (c) Personal fall protection systems, such as personal fall arrest, travel restraint, or positioning systems. (There was no guardrail system, safety net,

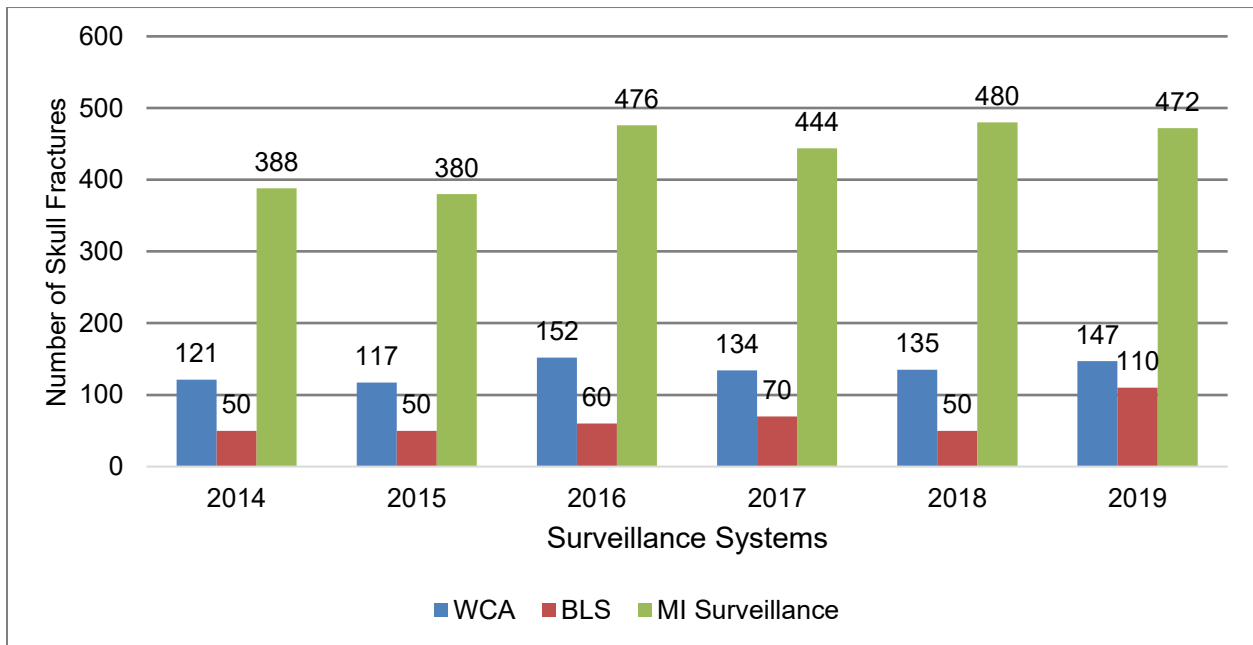
or personal protection used to prevent the employee from falling 77 ¾ inches off the top of the CN-02 Machine.) The company was previously cited for a violation of the Michigan Occupational Safety and Health Standard GI Part 2, Walking-Working Surfaces, 1910.28(b)(15); Hospitalizations, amputations, and losses of an eye. Within 24 hours after the inpatient hospitalization of 1 or more employees or an employee's amputation or an employee's loss of an eye, as a result of a work-related incident, you must report the inpatient hospitalization, amputation, or loss of an eye to MIOSHA. (The employer did not report an employee inpatient hospitalization to MIOSHA within the required twenty-four hours.); How quickly must each injury or illness be recorded? You must enter each recordable injury or illness on the MIOSHA 300 Log or 301 Incident Report within 7 calendar days of receiving information that a recordable injury or illness has occurred. (The employer did not record a recordable injury on their MIOSHA 300 Log.) The company did not correct the hazard during the inspection.

DISCUSSION

This is the fourth report on work-related skull fractures in Michigan and second report on hospitalized work-related intracranial injuries with Workers' Compensation as the expected payer in Michigan. Both reports cover calendar years 2018 and 2019.

The Michigan surveillance system for work-related skull fractures provides a more accurate estimate of the true number of work-related skull fractures than the employer-based reporting system maintained by BLS, which is the official source of work-related statistics. The Michigan system identified 480 work-related skull fractures in 2018, and 472 in 2019 in comparison to 50 estimated by BLS in 2018, and 110 in 2019 (Figure 10). The number of fatalities were six in 2018 and 11 in 2019.

Figure 10. Number of Work-Related Skull Fractures by Three Surveillance Systems, Michigan 2014 - 2019



For 2018 and 2019 BLS estimated only 16.8% of the 952 work-related skull fractures reported in the Michigan's multi-source reporting system. This is a slightly higher estimate compared to 2014-2017 for which BLS estimated 13.6% of the 1,688 skull fractures reported in Michigan's multi-source reporting system.

The BLS's undercount of work-related skull fractures is partially explained by the fact that BLS includes in its statistics only cases with one or more days away from work or with altered work duties, whereas the Michigan multi-source surveillance system counted all work-related skull fractures treated in a hospital or emergency department. Secondly, the BLS excludes self-employed, household employees and farm workers who work on farms with less than 11 employees. However, since the Michigan's skull fracture surveillance identified only 73 self-employed individuals in 2018 and 2019, and 61 farmers with work-related skull fractures, the difference in the type of workers covered in the BLS survey would not explain the undercount in the BLS data. Other possible explanations for the BLS undercount may be that employers are not providing complete reporting, the statistical sampling procedure of BLS, or employers are not properly identifying employees' injuries as skull fractures.

Worker's compensation was identified as the payer for only 59% of the work-related skull fractures treated at Michigan hospital and emergency department in 2018 and 2019. Another 58 (7.4%) were not covered by workers compensation (i.e., self-employed). We do not know the reasons why for the other 33.6% of the hospitalizations/ED visits worker compensation was not listed as the payer.

If one used Michigan's Workers' Disability Compensation Agency data as the sole source of skull fractures, one would identify many fewer cases than the other data sources combined. Reasons contributing to the WDCA undercount include: 1) The WDCA data set only included skull fractures that caused 7 or more consecutive days away from work; 2) WDCA excluded the self-employed, but again there were only sixty-nine self-employed workers; 3) Coding or miscoding errors in the WDCA data. The matching with hospital records showed that 168 work-related skull fractures between 2018 and 2019 identified from medical records were not classified as skull fractures in the WDCA data. Potentially there were other injuries in the WDCA database that were similarly misclassified but for which no medical records were received; 4) It is possible that some companies are handling skull fracture injuries unofficially and not reporting them to Workers' Compensation insurance companies or the WDCA.

Surveillance of work-related skull fractures is crucial to the recognition and prevention of these conditions. In 2018 and 2019, twenty-seven worksites were identified by the

surveillance data with a subsequent intervention by MIOSHA to reduce the hazard of a future work-related skull fracture or other serious injury to other employees. A large advantage of the Michigan surveillance system is that it not only provides a better count of the total number of work-related skull fractures, but the reports can also be used to identify specific workplaces to perform follow back investigations.

The Michigan surveillance data show patterns in the occurrence of occupational skull fractures. The data has been used in the national campaign to prevent work-related falls and we are in the process of developing hazard alerts where we see patterns in causes for the skull fractures. A hazard alert on assaults on health care workers has been developed.¹⁶

Beginning in 2014, we expanded the work-related skull fracture surveillance system to include individuals hospitalized overnight with work-related intracranial injuries including bleeds. This expansion in the number of conditions being tracked has provided a better understanding of the serious work-related head injuries that occur in Michigan. For 2018 and 2019, we have identified sixty-six work-related hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer from the hospital medical records where there was no skull fracture. There have been an additional thirteen hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer that had a skull fracture as an underlying cause of injury and therefore those cases were included in the 2018-2019 skull fractures dataset and not in the intracranial injuries report.

Unlike most conditions, the Michigan surveillance system for intracranial injuries reported fewer injuries than those estimated in the BLS employer-based system, 66 vs. 1,250. Presumably, many individuals with work-related concussions are not being treated in the emergency department or at hospitals but are being recognized by their employer. There were another 583 WDCA cases in 2018 and 2019 identified as concussions and only nine (1.5%) matched with hospital records. There were an additional 23 WDCA cases that matched with names from medical records, although they had an injury description in the WDCA database as something other than a "concussion". Due to a lack of the information

on what type of medical care workers received (i.e., hospitalization) we did not include those in the total of work-related hospitalized intracranial injuries.

MIFACE Program identified 43 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). Three of the 43 fatalities were identified by hospital medical records as hospitalized cases with Workers' Compensation as the expected payer.

Surveillance of work-related skull fractures and work-related hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer share many similarities. The majority of work-related skull fractures and hospitalized intracranial injuries with Workers' Compensation as the expected payer were among men, both with 79%, and among whites, 85 and 84% for both types of injuries, respectively. Injuries due to a fall and struck by incidents were the top two injury causes, with 70.3% for skull fractures and 75.7% for hospitalized intracranial injuries with Workers' Compensation as the expected payer. The Services (except Public Safety) NORA Sector Group had the highest number of work-related skull fractures and hospitalized intracranial injuries with Workers' Compensation as the expected payer, accounting for 32.6% and 27.3% of all injuries, respectively.

The ultimate goal of the skull fracture and hospitalized intracranial injuries with Workers' Compensation as the expected payer surveillance systems is to recognize and prevent work-related injuries and plan interventions to reduce the occurrence of workplace injuries. We plan to continue to collect and monitor data on occupational head injuries in Michigan, identify specific workplaces to perform follow back investigations, and develop educational materials, including hazard alerts.

REFERENCES

1. CDC. Surveillance for Traumatic Brain Injury -- Related Deaths --United States, 1997—2007. MMWR 2011;60(SS05);1-32.
2. Michigan Administrative Code Rule 325.301-306, available at: <https://ars.apps.lara.state.mi.us/AdminCode/DeptBureauAdminCode?Department=Health%20and%20Human%20Services&Bureau=All>
3. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2018. Skull Fractures data for all U.S. obtained by navigating through screens starting at the following website: <http://data.bls.gov/gqt/InitialPage>
4. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2019. Skull Fractures data for all U.S. obtained by navigating through screens starting at the following website: <http://data.bls.gov/gqt/InitialPage>
5. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2018. Skull Fractures data for Michigan obtained by navigating through screens starting at the following website: <http://data.bls.gov/gqt/InitialPage>
6. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2019. Skull Fractures data for Michigan obtained by navigating through screens starting at the following website: <http://data.bls.gov/gqt/InitialPage>
7. Michigan Fatality Assessment and Control Evaluation available at: http://www.oem.msu.edu/MiFACE_Program.aspx
8. International Classification of Diseases, Tenth Revision, Clinical Modification available at: <https://www.cdc.gov/nchs/icd/icd10cm.htm#> FY 2017 release of ICD-10-CM

9. United States Census Bureau. North American Industry Classification System.

<https://www.census.gov/naics/>

10. Centers for Disease Control and Prevention. National Occupational Research Agenda. <https://www.cdc.gov/nora/sectorapproach.html>

11. National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research, Employment Labor Force (ELF) Query System.

<https://wwwn.cdc.gov/wisards/cps/>

12. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2018. Intracranial Injuries data for all U.S. obtained by navigating through screens starting at the following website:

<http://data.bls.gov/gqt/InitialPage>

13. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2019. Intracranial Injuries data for all U.S. obtained by navigating through screens starting at the following website:

<http://data.bls.gov/gqt/InitialPage>

14. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2018. Intracranial Injuries data for Michigan obtained by navigating through screens starting at the following website:

<http://data.bls.gov/gqt/InitialPage>

15. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2019. Intracranial Injuries data for Michigan obtained by navigating through screens starting at the following website:

<http://data.bls.gov/gqt/InitialPage2>

16. Stop Work-Related Assaults in the Health Care Setting. Available at:

https://oem.msu.edu/images/Alerts/HAZ_ALERTS_-_assaults_in_healthcare_7_2019_final.pdf