Work-Related Skull Fractures in Michigan: Fifth Report (January 2020– December 2021)

and

Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer: Third Report (January 2020 – December 2021)

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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 fifth report on occupational skull fractures in Michigan; it covers the years 2020 and 2021. These are the key findings:

- Work-related skull fractures were identified through multiple reporting sources.
  - There were 396 work-related skull fractures, including 18 deaths, in 2020.
  - There were 399 work-related skull fractures, including 2 deaths, in 2021.
- For 2020, the Federal reporting system that relies on employer reporting, estimated 220 work-related skull fractures in Michigan or 55.6% of the 396 work-related skull fractures reported in Michigan's multi-source reporting system. The BLS has not released the 2021 data of work-related injuries at the time of this report data.
- The most common type of medical encounter was an emergency room visit (56.1%).
- Seventy-eight percent of all work-related skull fractures were among men.
- Eighty-two percent of all work-related skull fractures were among whites.
- Facial bones were the most common location of the fracture (74.2%).
- The most common type of work-related skull fracture was a depressed skull fracture (broken bone pushed inward) (34.9%).
- Thirty-two 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 (50.8%). "Struck by" injuries were the leading cause of injuries in the Manufacturing NORA Sector Group (41.0%).
- Workers' Compensation was the expected payer for only 58.5% of the 624 cases, which identified insurance type in the hospital/ED records.
- The Michigan OSHA program completed inspections at 14 worksites identified by the skull fracture surveillance system. MIOSHA issued 30 violations and assessed $87,800 in fines.

BACKGROUND

This is the fifth report on occupational skull fractures in Michigan. The report is based on data for 2020 and 2021. 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 3,730 work-related skull fractures (excluding fractures to eye(s)) in 2020 (incidence rate of three skull fractures per 100,000 full-time workers).[3] 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 220 work-related skull fractures in 2020. This corresponds to a rate in Michigan to six work-related skull fractures per 100,000 full-time workers.[4] BLS has not released the 2021 data on work-related injuries at the time of this report.

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)[5]

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 code[6] 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, dates of admission and discharge, patient demographics, city and county of residence, source of payment, employer information (name, address, NAICS code[7]), injury date, cause of injury, type of fracture, and loss of consciousness. Skull fracture data were manually linked to records in the WDCA database using SAS 9.4. Consecutive matches using SSD, then individual's first and last name, then date of birth, and finally date of injury was performed. Matches were visually inspected for verification. Afterword, 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. The final matched data sets had NAICS codes converted to a NORA Sector Group for analysis.[8]

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 2020 or 2021, 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 SAS 9.4. 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, and gender for 2020 through 2021.[9] Rates were calculated by taking the average number of persons employed in Michigan from 2020-2021. Incidence rates of work-related skull fracture by county of

residence were calculated using the U.S. Census, Department of Labor's Local Area Unemployment Statistics for denominators.[10]

The BLS Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the 2020 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.[3-4] For 2020, 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. As stated previously the BLS site does not contain data on fractures on 2021.

RESULTS

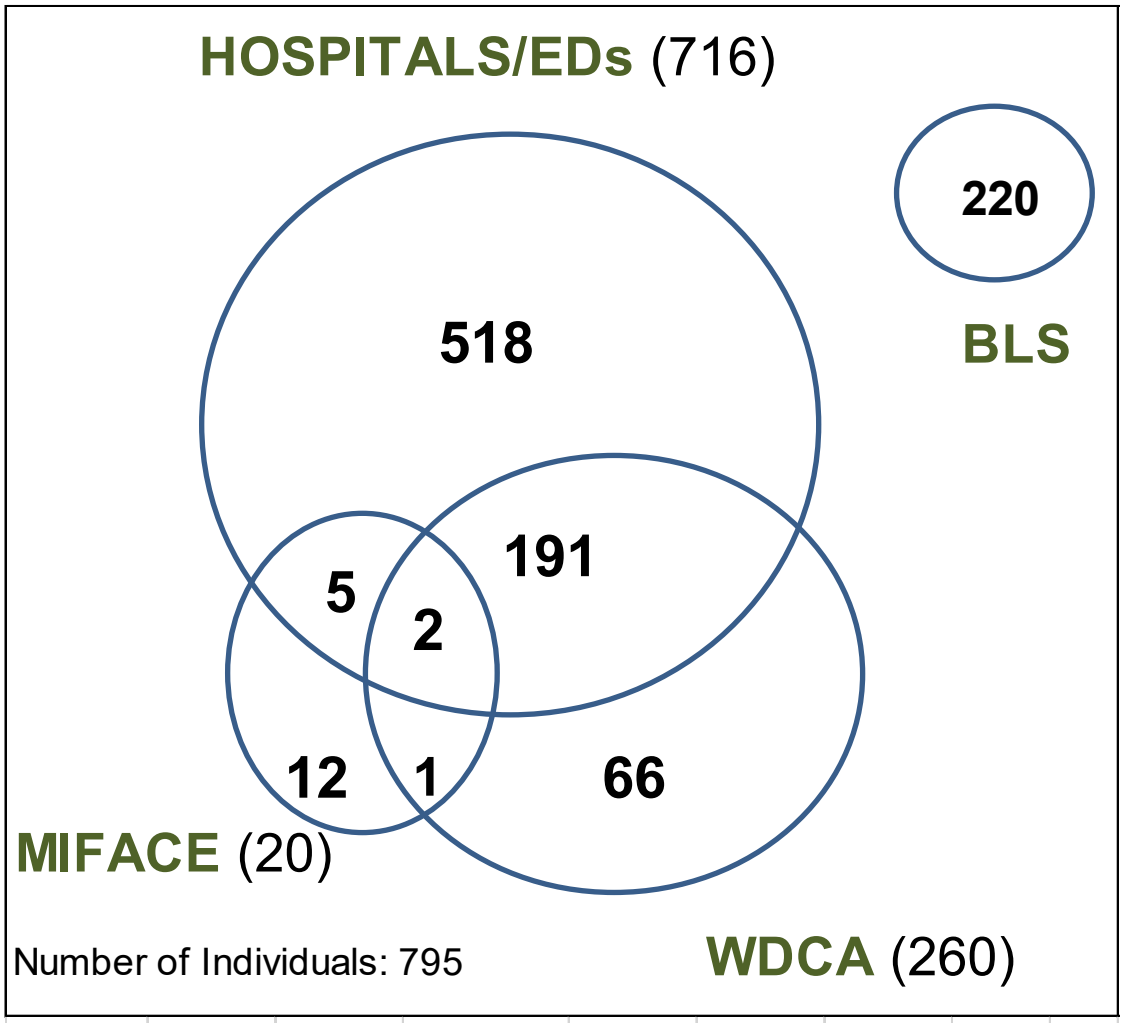
In 2020 and 2021, there were, respectively 396 and 399 individuals that had a work-related skull fracture.

2020-2021 combined: There were 795 work-related skull fractures in 795 unique individuals.

Reporting Sources

The number of 2020-2021 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 2020-2021



* There is presumably an overlap between the 220 estimates of the BLS and the Michigan reporting sources (HDC, MIFACE, and WDCA), but the BLS does not allow access to their data, thus matching to assess the degree of overlap was not possible.

2020-2021 Reporting Sources

Hospital/ED reports identified 716 skull fractures, WDCA 260 skull fractures, and MIFACE 20 fatalities. Hospital/ED reports matched with 191 WDCA reports and 7 MIFACE reports. Another two skull fractures were identified by all the reporting sources. Sixty-six skull fractures were identified by the WDCA data source only. One skull fracture was identified by MIFACE and WDCA but was not reported by a hospital. Twelve 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 260 cases found in the WDCA database. One hundred and ten were identified because they had been classified by WDCA 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 110 records, 43 matched with hospital/ED records, one matched with both hospital/ED records and MIFACE records, and 66 did not match with either hospital/ED or MIFACE records. The other 150 cases from WDCA were included because they matched with reports 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 150 were: 42 “Multiple Injuries”, 22 “Fracture” (other than skull), 22 “Unclassified”, 26 “Crush/Contusion”, 18 “Cut/Laceration”, 10 “Concussion”, 10 “Strains/Sprains”. Matches were made based on the employee’s name, date of birth, date of injury, employee’s zip code and employer.

An emergency department visit was the most common type of medical encounter, 446 (56.0%) cases, followed by hospitalization in 235 (29.5%) cases. The type of medical care that workers received was not available for 67 WDCA cases and 12 fatalities (Table 1).

Table 1. Work-Related Skull Fractures by the Type of Medical Encounter, Michigan 2020-2021

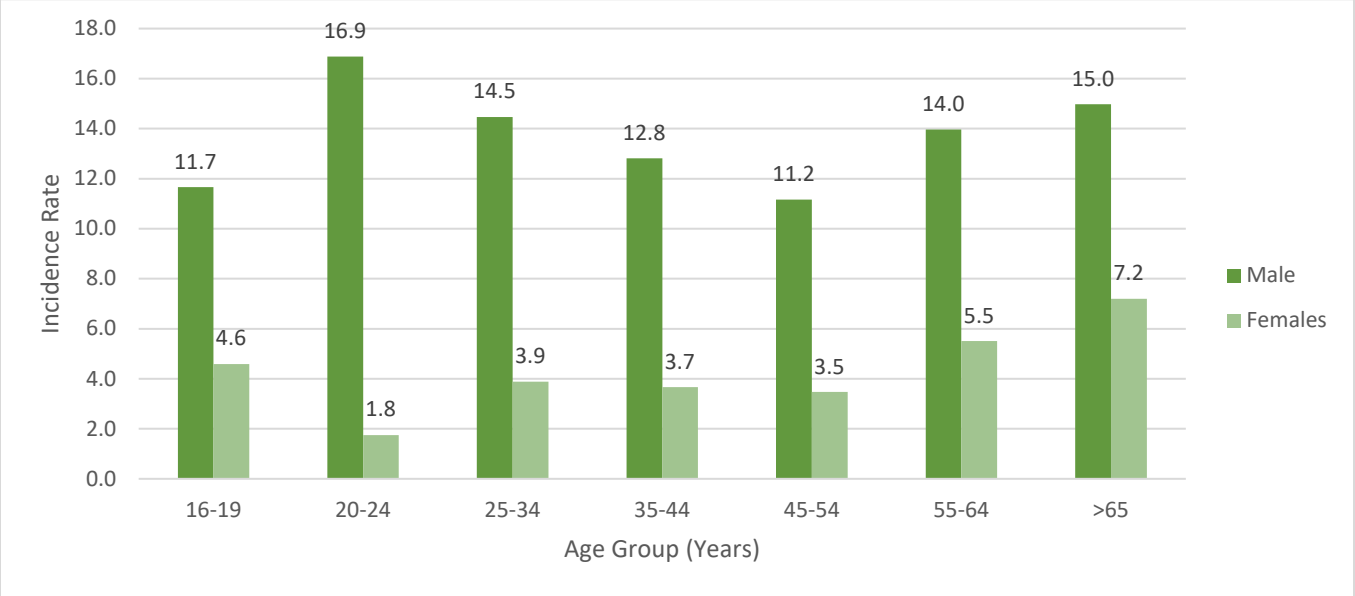
Medical Encounter Type	2020-2021	
	Number	Percent
Hospitalization	234	29.4
Emergency Department	446	56.1
Outpatient	36	4.5
Death Certificate	12	1.5
Unknown	67	8.4
Total	795	100.0

Characteristics of Injured Workers

Age and Gender

Age was not available for two 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 41. Six hundred and twenty-two (78.2%) 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 16.9/100,000. For females, the age group with the highest rate of skull fractures was 65+ (7.2/100,000).

Figure 2. Work-Related Skull Fracture Rates by Age Group and Gender, Michigan 2020-2021*



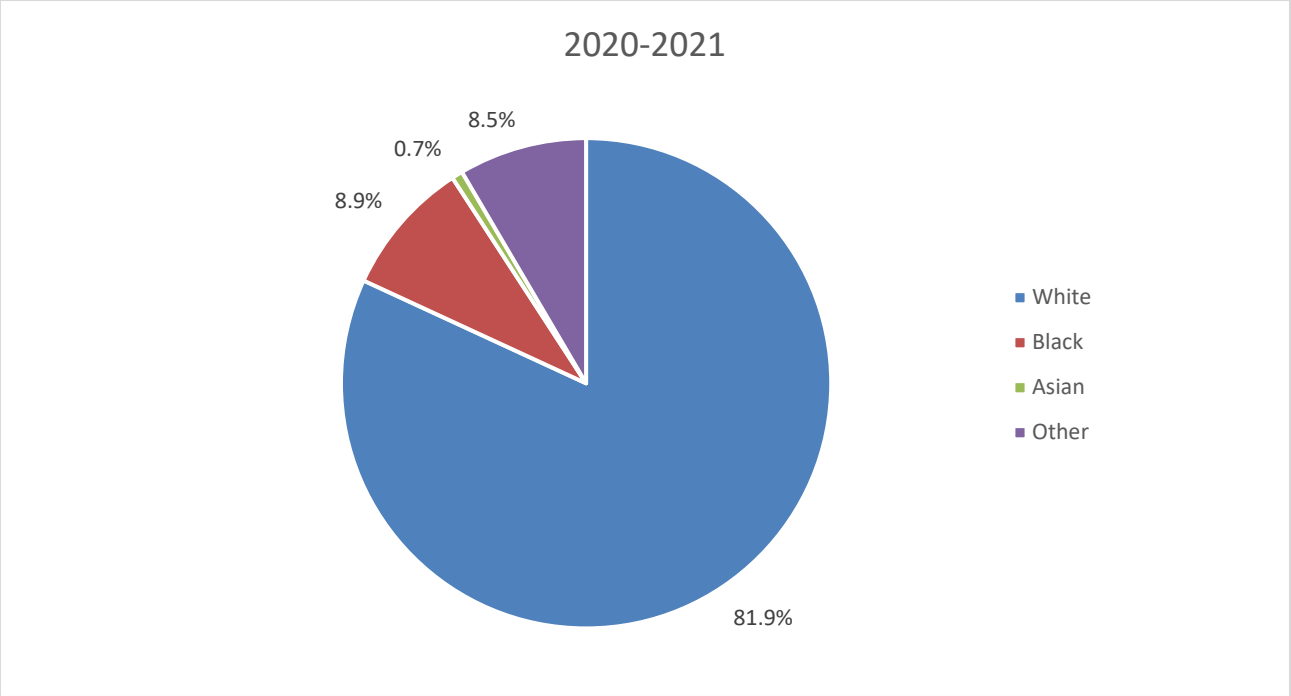
*Data Sources: Number of work-related skull fractures – Michigan hospital/ED medical records, MIFACE, and WDCA; Total number of workers by age group and sex – NIOSH Employment Labor Force Query System (BLS CPS). [9]
Note: Rates are the number of workers sustaining a skull fracture per 100,000 workers.

Race and Ethnicity

The race of workers with work-related skull fractures was available for 414 individuals (52.1%) (Figure 3). Three hundred and thirty-nine (81.9%) were white, 37 (8.9%) were African American, three (0.7%) were Asian, and 35 (8.5%) were Other.

Information on ethnicity was provided for 296 (37.2%) individuals. Of the 296 individuals, 34 (11.5%) were of Hispanic origin and 262 (88.5%) individuals were not of Hispanic origin.

Figure 3. Race Distribution of Work-Related Skull Fractures, Michigan 2020 - 2021*



*Race information available for 414 (52.1%) 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-10 codes.

Fractures of facial bones occurred most often (74.1%), followed by fractures of the base of the skull (11.6%) (Table 2).

Table 2. Work-Related Skull Fractures by Part of Skull, Michigan 2020-2021

Part of Skull Injured	2020-2021	
	Number	Percent
Vault	30	3.8
Base	92	11.6
Face Bones	590	74.1
Other and Unqualified	58	7.3
Multiple	25	3.1
Total	795	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 395 (49.7%) of the fractures. There were 138 (34.8%) depressed skull fractures, 117 (29.5%) linear fractures, 66 (16.7%) compound fractures, 40 (10.1%) comminuted fractures, and 34 (8.6%) displaced fractures (Table 3).

Table 3. Work-Related Skull Fractures by Type of Fracture, Michigan 2020 - 2021*

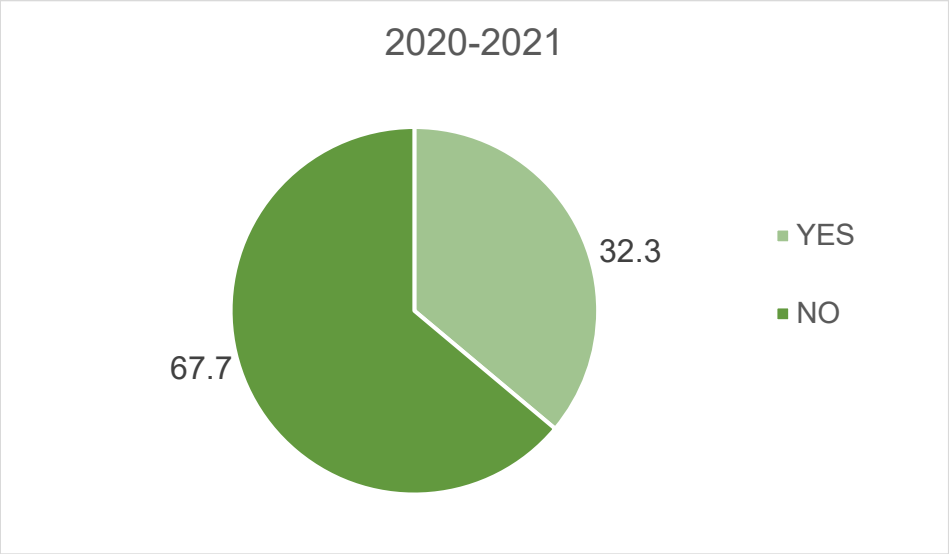
Type of Fracture	2020-2021	
	Number	Percent
Depressed	138	34.8
Linear	117	29.5
Compound	66	16.7
Comminuted	40	10.1
Displaced	34	8.6
Total	395	100.0

*Type of skull fracture was not specified for 400 (51.3%) cases

Loss of Consciousness

Whether an individual lost consciousness was described for 586 (73.7%) cases (Figure 4).

Figure 4. Work-Related Skull Fractures by Loss of Consciousness Status, Michigan 2020-2021*



*For 209 (26.3%) cases it was unknown if individuals lost consciousness due to the injury to head

County of Residence

There were 767 Michigan residents for whom the county of residence was known (Table 4 and Figure 5). There were 31 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 142 (18.5%) cases, followed by 73 (9.5%) cases in Oakland County, and 66 (8.6%) cases in Macomb County. Rates of skull fractures were calculated for those counties that had six or more skull fractures take place in the county; as rates in counties that had five or less skull fractures were not considered statistically reliable. Among the counties that had six or more skull fractures the ones with the highest rates were Gratiot (30.8 skull fractures per 100,000 workers), followed by Emmet (25.9 skull fractures per 100,000 workers), and Tuscola (23.5 skull fractures per 100,000 workers). Since the majority of counties did not have a sufficient number of skull fractures to calculate a statistically reliably rate (33 out of 83 counties (39.8%), the map of Michigan displays the number of skull fractures rather than the rate.

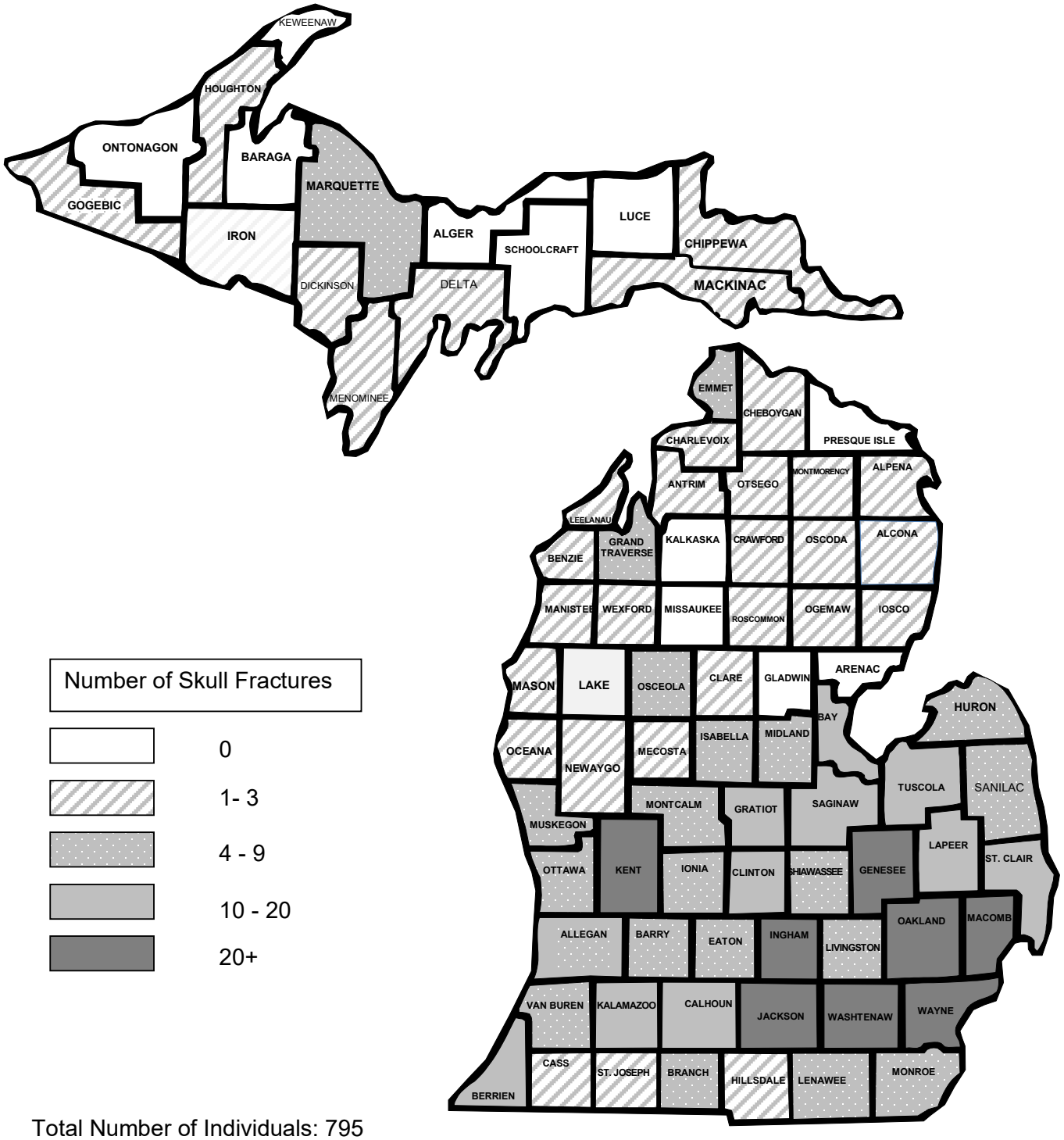
Table 4. Number of Work-Related Skull Fractures by County of Residence, Michigan 2020-2021

County	Count	Rate	County	Count	Rate
ALCONA	1	*	LAPEER	11	15.0
ALGER	0	0.0	LEELANAU	3	*
ALLEGAN	8	6.9	LENAWEE	7	8.4
ALPENA	1	*	LIVINGSTON	9	4.7
ANTRIM	2	*	LUCE	0	0.0
ARENAC	0	0.0	MACKINAC	2	*
BARAGA	0	0.0	MACOMB	66	8.2
BARRY	5	*	MANISTEE	3	*
BAY	13	14.4	MARQUETTE	6	10.3
BENZIE	2	*	MASON	1	*
BERRIEN	13	9.8	MECOSTA	3	*
BRANCH	7	19.2	MENOMINEE	1	*
CALHOUN	15	13.5	MIDLAND	7	9.6
CASS	1	*	MISSAUKEE	0	0.0
CHARLEVOIX	2	*	MONROE	9	6.6
CHEBOYGAN	1	*	MONTCALM	6	11.8
CHIPPEWA	1	*	MONTMORENCY	1	*
CLARE	4	*	MUSKEGON	8	5.8
CLINTON	11	14.7	NEWAYGO	2	*
CRAWFORD	3	*	OAKLAND	73	6.0
DELTA	1	*	OCEANA	4	*
DICKINSON	2	*	OGEMAW	3	*
EATON	5	*	ONTONAGON	0	0.0
EMMET	8	25.9	OSCEOLA	5	*
GENESEE	28	8.7	OSCODA	1	*
GLADWIN	1	*	OTSEGO	3	*
GOGEBIC	2	*	OTTAWA	7	2.3
GRAND TRAVERSE	7	7.7	PRESQUE ISLE	0	0.0
GRATIOT	10	30.8	ROSCOMMON	3	*
HILLSDALE	3	*	SAGINAW	13	8.6
HOUGHTON	1	*	ST CLAIR	11	8.1
HURON	6	21.3	ST JOSEPH	2	*
INGHAM	21	7.8	SANILAC	4	*
IONIA	7	12.5	SCHOOLCRAFT	0	0.0
IOSCO	1	*	SHIAWASSEE	5	*
IRON	0	0.0	TUSCOLA	10	23.5
ISABELLA	4	*	VAN BUREN	7	11.0
JACKSON	20	14.8	WASHTENAW	24	6.6
KALAMAZOO	18	7.4	WAYNE	142	9.9
KALKASKA	0	0.0	WEXFORD	4	*
KENT	35	5.3	Out of state	31	N/A
KEWEENAW	0	0.0			
LAKE	0	0.0	TOTAL	767	8.5

Does not include 28 individuals with unknown County of Residence

Rates are suppressed if the count is between 1 and 5 because such rates are not statistically reliable

Figure 6. Number of Work-Related Skull Fractures by County of Residence, Michigan 2020-2021



Total Number of Individuals: 795
Out of State Individuals: 31
County was unknown for 28 individuals

Cause of Injury

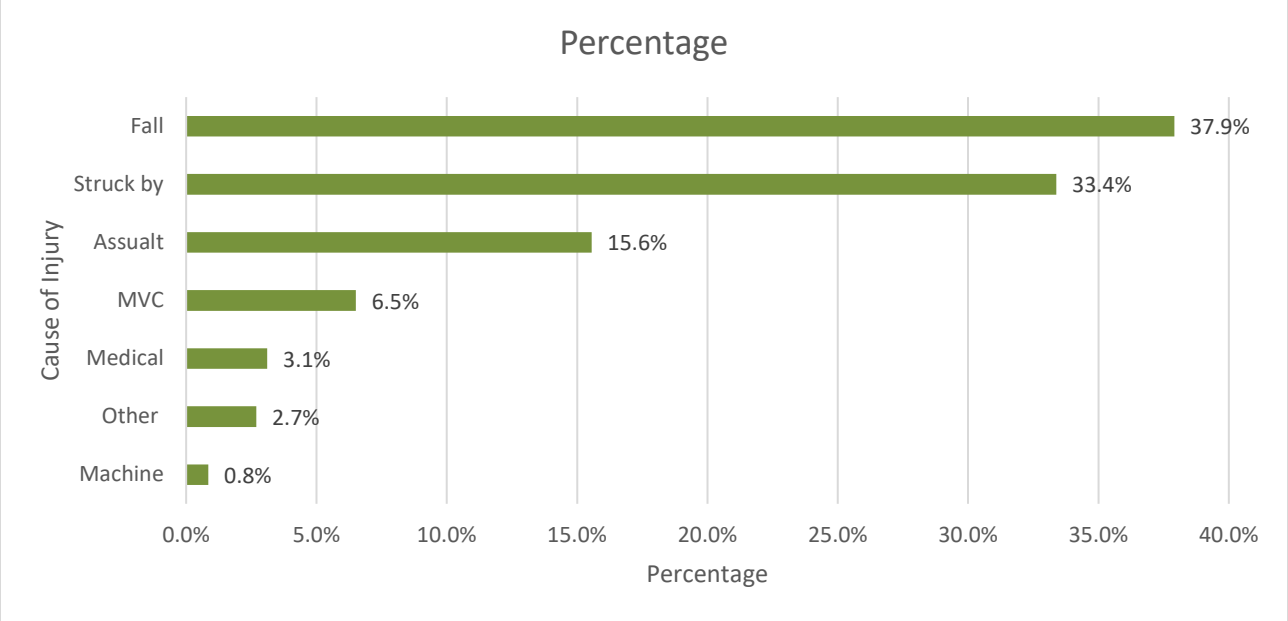
Causes of skull fractures were:

- Fall – a fall can be to the same level (e.g., 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 stationery 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 707 (88.9%) cases (Figure 6). It was unknown for 88 cases. The predominant cause of a skull fracture was a fall in 268 (37.9%) cases, followed by a struck by incident in 236 (33.4%) cases, an assault in 110 (15.6%) cases, a motor vehicle accident in 46 (6.5%) cases, medical condition in 22 (3.1%) cases, “other” in 19 (2.7%) cases, and a machine in 6 (0.8%) 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 the twenty fatalities between 2020 and 2021, nine were caused by MVC, two from being struck by an object, and one was a fall. The other eight had unknown definitive causes for the skull fracture.

Figure 6. Percentage of Work-Related Skull Fractures by Cause of Injury, Michigan 2020 - 2021*



*Cause of injury was specified for 707 (88.9%) cases.

NORA Sector Groups

For 618 (77.7%) cases, including 58 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 184 (29.8%) cases, followed by the Construction Sector Group with 118 (19.0%) cases, and then the Manufacturing Sector Group with 83 (13.4%) cases. Among the NORA Sector Groups with enough cases to be statistically reliable, Agriculture, Forestry & Fishing, excluding wildland firefighting, had the highest rate of skull fractures with 33.3/100,000 workers. Construction had the second highest rates among NORA sectors with 23.1 skull fractures for every 100,000 workers.

Table 5. Number, Percent and Rate of Work-Related Skull Fractures by Industry, Michigan 2020 - 2021*

NORA Sector Group	NAICS Code	Number	Percent	Rate
Agriculture, Forestry & Fishing (except Wildland Firefighting)	11	38	6.1	32.5
Construction	23	118	19.0	23.1
Healthcare & Social Assistance	62, 54194, 81291	62	10.0	4.5
Manufacturing	31-33	83	13.4	5.1
Mining (except Oil & Gas Services)	21	0	0.0	0.0
Oil & Gas Extraction	211, 213111, 213112	1	0.2	*
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	23	3.7	4.3
Services (except Public Safety)	51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92	184	29.8	7.4
Transportation, Warehousing & Utilities	48-49, 22	47	8.2	10.4
Wholesale & Retail Trade	42, 44-45	62	10.4	5.6
Total		618	100.0	7.4

***Sufficient information for sector groups classification was available for 821 (86.1%) of cases.
[1]Rates 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 (41.0%). “Fall” was the predominant cause of a skull fracture in the Services (except Public Safety) (27.2%), Construction (50.8%), Wholesale and Retail Trade (46.8%), and the Healthcare & Social Assistance (29.0%) Sector Groups.

Table 6. Number of Work-Related Skull Fractures by Cause of Injury among the Five NORA Sector Groups with the Largest Number of Work-Related Skull Fractures, Michigan 2020 - 2021

NORA Sector Group	Struck By	Fall	Machine	Assault	MVC	Other	Medical Condition	Unk	TOTAL
Services (except Public Safety)	45	50	1	35	7	5	8	33	184
Construction	38	60	0	4	5	2	0	9	118
Manufacturing	34	22	3	2	4	3	6	9	83
Wholesale & Retail Trade	14	29	1	8	3	0	1	6	62
Healthcare & Social Assistance	3	18	0	24	1	3	1	12	62

Source of Payment

Workers' Compensation was the expected payer in 365 (58.5%) of the 624 work-related skull fractures for which source of payment was in the medical record (Table 7). For 171 skull fractures payment source could not be identified. Of the 259 cases for which Workers' Compensation was not listed as a payment source in medical records, 41 were matched to a case in the WDCA database. Of those 41 cases, eight were classified as a skull fracture and 29 had an injury description in the WDCA database as something other than "skull fracture".

Table 7. Number and Percent of Work-Related Skull Fractures by Payment Source, Michigan 2020-2021

Expected Source of Payment	2020-2021	
	Number	Percent
Workers' Compensation	365	58.5
Commercial Insurance	127[1]	20.4
Medicare/Medicaid	102[2]	16.3
Self-Pay	18[3]	2.9
Other Government	12[4]	1.9
Total	624	100.0

Data Source: Michigan hospital/ED medical records.
*Payment source was unknown for 91 (12.7%) cases
[1]Includes 14 self-employed workers, [2]Includes 18 self-employed workers,
[3]Includes 4 self-employed workers,[4]Includes 2 self-employed workers.

MIOSHA Inspections

MIOSHA performed 14 inspections at 13 different workplaces between 2020 through 2021 for a work-related skull fracture. At three of the workplaces a fatal skull fracture had occurred. Table 8 illustrates the distribution of violations and penalties assessed by the NORA Sector Group type of the 13 inspected workplaces. In all workplaces that were investigated 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. 15

Table 8. Number of MIOSHA Workplace Enforcement Inspected, Violations, Penalties and Recommendations for a Work-Related Skull Fracture by Industry, Michigan 2020 - 2021

NORA Sector Group	# of Enforcement Inspections	# of Companies Cited	# of Violations	# of Recom.	Total Penalties Assessed
Construction	3	2	2	0	$400
Manufacturing	6	6	15	0	$63,700
Services (except Public Safety)	1	1	5	0	$2,300
Agriculture	0	0	0	0	$0
Healthcare & Social Assistance	0	0	0	0	$0
Wholesale & Retail Trade	3	3	7	0	$19,900
Transportation, Warehousing & Utilities	1	1	1	0	$1,500
Total	14*	13**	30	0	$87,800

*Includes 3 inspections of fatal injuries.

**13 (100%) of these companies had not corrected the hazard at the time of the inspection.

Examples of Work-Related Skull-Fracture MIOSHA Enforcement Inspections

- *Drill Press Operator*

  A woman in her 50s presented to the ER after sustaining a skull fracture at work. The woman was working on a drill press when she attempted to reposition the workpiece without turning off the power. First her glove got caught in the machine, which then pulled her sleeve into the machine, and then pulled her forward so that her face slammed into the drill press machine. MIOSHA investigated the worksite and found one serious violation upon inspection. “When milling, all the following provisions apply: (a) Manual adjustment or measurements at the point of operation shall be made only after the tool and workpiece have stopped; (b) Machine torque shall not be used to loosen nuts; (c) A chip guard shall be installed between the point of operation and the operator and other employees within range; and (d) The workpiece shall be securely clamped before the bate moves in the direction of the cutter or the cutter moves to the work piece. This hazard was not corrected prior to the OSHA inspection. The overall investigations led to one citation with one serious violation for a total proposed penalty of $400.

- *Truck Driver*

  A male in his early sixties was hospitalized for five days for a skull fracture after he slipped and sustained a ten-foot fall from a fuel delivery truck onto gravel. He was delivering fuel to a landscaping company. MIOSHA found three serious and two other-than-serious violations: “Except as provided elsewhere in in § 1910.28 The employer must ensure that each employee on walking-working surfaces with an unprotected side or edge that is 4 ft (1.2m) or more above a lower level is protected from falling by one or more of the following: (i) Guardrail systems; (ii) Safety net systems; or (iii) Personal fall protection systems, such as personal fall arrest, travel restraint, or positioning systems. (An employee on top of the Hutchinson tanker was not protected from a fall of 9’ – 8-1/2’’ to the ground below at customer locations, and at the bulk terminal by a guardrail, safety net, or personal fall protection system. Before any employee is exposed to a fall hazard, the employer must provide training for each employee who uses personal fall protection systems or who is required to be trained as specified elsewhere in subpart D of 29 CFR 1910. Employers must ensure employees are trained in the requirement of this paragraph (Employees were not trained on the use and requirement of fall protection while on top of the Hutchinson tanker while in the field making deliveries, and at the bulk terminal). The employer must ensure that each flight of stairs having at least three treads and at least four risers is equipped with stair rail systems and handrails as found in Table D-2, Stairway Handrail Requirements. (Employees using the fold down statis at the bulk terminal to access the tops of the tankers are not protected by stair rails.) Within 24 hours after an inpatient hospitalization of 1 or more employees an employee must report the inpatient hospitalization, to MIOSHA Each employer required to keep records of fatalities, injuries, and illnesses must record each fatality, injury, and illness that involves all of the following (i) Is work related; (ii) Is a new case; (iii) Meets 1 or more of the general recording criteria of R 408.22112 to R 408.22112f or the application to specific cases of R 408.22113 to R 408.22119. (The employer did not record the injury onto their OSHA 300 log. The employer did not complete a MIOSHA 301 incident report for the injury). There were two citations and five violations in total with a proposed penalty of $11,500.

HOSPITALIZED INTRACRANIAL INJURIES WITH WORKERS' COMPENSATION AS THE EXPECTED PAYER

EXECUTIVE SUMMARY

This is the third 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 2020 and 2021 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 27 work-related intracranial injuries in 2020.
  - There were 33 work-related intracranial injuries in 2021.
- There were an additional 16 (five cases in 2020, and 11 cases in 2021) 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 2020-2021 skull fractures dataset and not in the intracranial injuries report. There were 507 (218 cases in 2020, and 289 cases in 2021) WDCA cases in 2020-2021 identified as concussions (brain, cerebral). Of the 507 WDCA cases, six matched with hospital medical reports and 501 did not match with hospital reports. There were an additional 31 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 14 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). Two of the 14 fatalities were identified by hospital medical records as hospitalized cases with Workers' Compensation as the expected payer and these two case were included in the total.
- For 2020, the Federal reporting system that relies on employer reporting estimated 1,330 work-related intracranial injuries; these intracranial injuries are reported by employers when the worker has been given limited work duties or has days away from work irrespective of the employees' medical encounter type.
- Eighty two percent of all work-related intracranial injuries were among men.
- Sixty-two 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 (63.3%).
- Three NORA Sector Groups – Services (except Public Safety), Manufacturing and Wholesale, and Retail Trade Sector Groups accounted for over half (62.0%) of all work-related intracranial injuries.
- The Michigan OSHA program completed inspections at two worksites identified by the intracranial surveillance system. MIOSHA issued four violations and assessed $28,000 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 9). This is the third report on work-related hospitalized intracranial injuries with Workers' Compensation as the expected payer. The report is based on data for 2020 through 2021.

Nationally, the Bureau of Labor Statistics (BLS), the official source of work-related injury statistics, reported 17,910 work-related intracranial injuries in 2020 (incidence rate of 1.6 workers with intracranial injuries per 100,000 full-time workers).[12] Currently at the time of this report, BLS has not released the 2021 data for work-related injuries. 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 1,330 work-related intracranial injuries in 2020 which corresponds to a rate of 4.1 work-related intracranial injuries per 100,000 full-time workers, respectively.[11]

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 code[11] 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,

NAICS code[7]), self-employed status, injury date, cause of injury, and ICD-9/ICD-10 code. Once these hospitalized intracranial injury data were entered into a Microsoft Access database, they were entered into SAS 9.4. These hospitalized intracranial injury data were manually linked to records in the WDCA database using SAS 9.4. 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.[7]

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 2020 or 2021, 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.

All data analysis was performed using SAS 9.4. 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 2020 through 2021.[9]

The BLS Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the 2020 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]

Code 16XXXX (Intracranial Injuries) was used. All workers, irrespective of their age, were selected.

RESULTS

In 2020 and 2021,respectively 27 and 33 individuals had a work-related intracranial injury reported from hospital for which Workers' Compensation was the expected payer.

2020 - 2021 combined: There were 60 work-related hospitalized overnight intracranial injuries with Workers' Compensation as the expected payer.

There were an additional 18 intracranial injuries (7 cases in 2020, and 11 cases in 2021) hospitalized overnight with Workers' Compensation as the expected payer that had a skull fracture as an underlying cause of injury and therefore were included in the 2020-2021 skull fractures dataset and not in the intracranial injury's dataset.

Reporting Sources

Michigan hospitals identified 60 work-related hospitalized overnight intracranial injuries without a skull fracture with Workers' Compensation as the expected payer.

There were 513 (222 cases in 2020, and 291 cases in 2021) WDCA cases identified as concussions (brain, cerebral) to one of the following parts of the body: Brain; Head, multiple; Head, unspecified; or Skull. Only six of the concussions in the WCDA database matched with hospital records.

WDCA did not provide information on what type of 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 513 WDCA cases that were identified because they had been classified as concussion, six matched with hospital reports and 507 did not match with hospital reports. There were additional 25 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 25 were: 7

"Unclassified", 6 "Crush/Contusion", 5 "Fracture, 4 "Multiple Injuries", 1 "Cut/Laceration", 1 "Inflam-Joints", and "Other Injury/Nec". Matches were made based on the employee's name, date of birth, date of injury, employee's zip code, and employer.

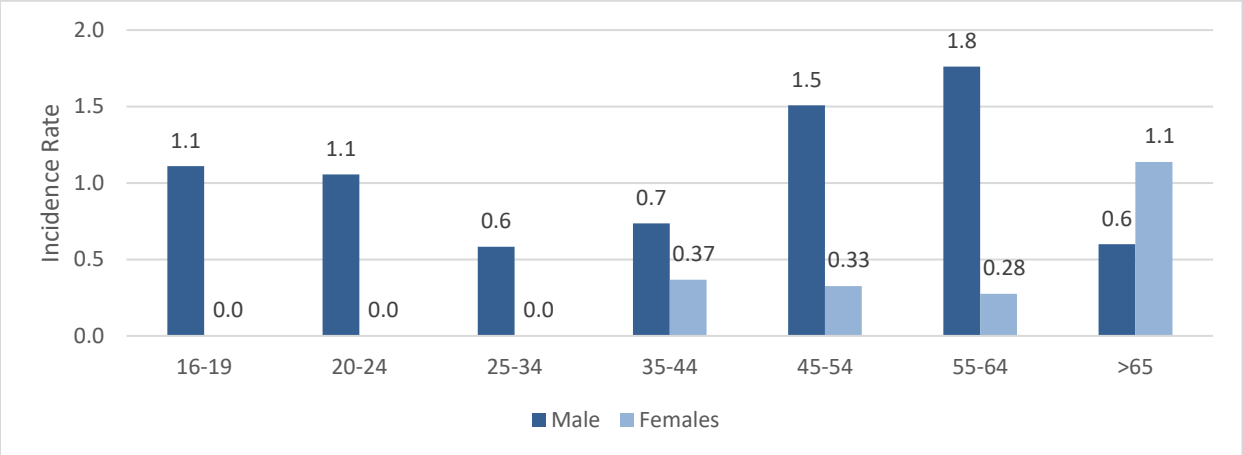
MIFACE Program identified 14 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). One of the 14 fatalities were identified by hospital medical records as a hospitalized case with Workers' Compensation as the expected 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 17 to 69 years. The average age was 46.9 and median age was 49. Forty-nine (81.7%) of all work-related intracranial injuries were among men. Figure 8 displays intracranial injuries rates by age group and gender. For females, rates were highest for workers in the 65+ age group with 1.1/100,000. For males. Rates were highest for workers in the age group of 55 – 64, 1.8/100,000.

Figure 8. Incidence Rates of Work-Related Hospitalized Intracranial Injury with Workers' Compensation as the Expected Payer Rates by Age Group and Gender, Michigan 2020-2021*



*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 (39; 65.0%), 24 (61.5%) were white, 9 (23.1%) were African American, 2 (5.1%) were Asian, and 4 (10.3%) were Other.

Of the 32 individuals where ethnicity was available; 5 (15.6%) were of Hispanic origin and 27 (84.4%) individuals were not of Hispanic origin.

County of Residence

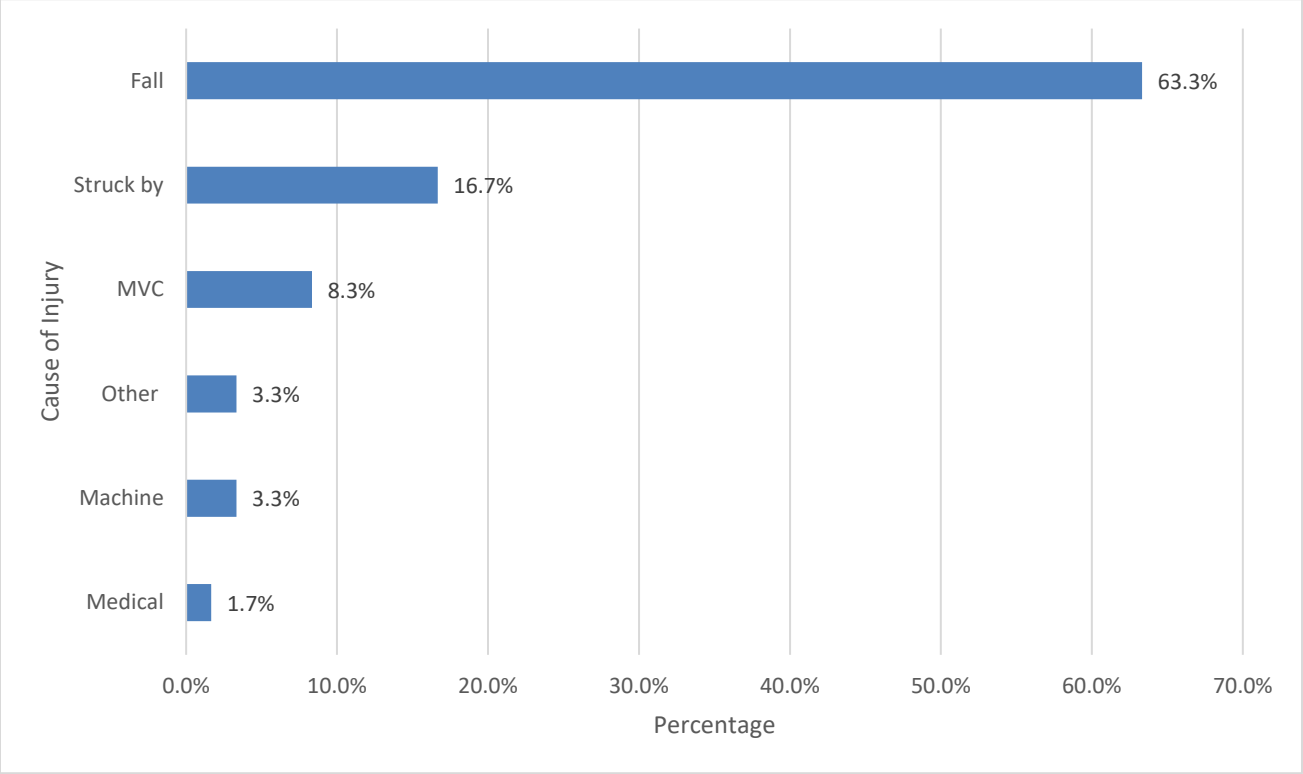
The county of residence was known for all Michigan residents. There were four out-of-state residents. It should be noted that the county of residence would not necessarily be the same county where the individual was injured. Wayne County had the highest number of residents with a work-related hospitalized intracranial injury with 13 (21.7%) cases, followed by seven (11.7%) cases in Oakland County and 6 (10.0%) cases in Macomb County. Due the majority of counties having 5 or less intercranial injury incidence rates by county were not calculated.

Cause of Injury

The causes of intracranial injuries were classified using the same categories as for skull fractures (See page 15).

The cause of work-related hospitalized intracranial injuries with Workers' Compensation as the payer was specified for 58 (96.7%) cases (Figure 9). It was unknown for two cases. The predominant cause of hospitalized intracranial injuries was a fall in 38 (63.3%) cases, followed by a struck by incident in 10 (16.7%) cases, motor vehicle crash in 5 (8.3%) cases, two caused by machine (3.3%) cases, "other" in two (3.3%) case, and one medical case (1.7%). 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 Transportation, Warehousing & Utilities sector had the highest percentage of intracranial injuries due to a fall with all cases being caused by fall (Table11).

Figure 9. Percentage of Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer by Cause, Michigan 2020 - 2021*



*Cause of work-related hospitalized intracranial injury was not specified for two (3.3%) individuals.

NORA Sector Groups

For 50 (83.3%) intracranial injuries 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 13 (26.0%) cases, followed by the Manufacturing Sector Group with 10 (20.0%) cases, and then the Wholesale and Retail Trade with eight (16.0%) cases. The Construction Sector Group had the highest rate of hospitalized intracranial injuries with 2.3 injuries per 100,000 workers, followed by wholesale and retail trade sector group with 0.7 injuries per 100,000 workers.

Table 10. Number, Percent and Rate of Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the expected payer by Industry, Michigan 2020 – 2021[1]

NORA Sector Group	NAICS Code	Number	Percent	Rate[2]
Agriculture, Forestry & Fishing (except Wildland Firefighting)	11	0	–	–
Construction	23	12	24.0	2.3
Healthcare & Social Assistance	62, 54194, 81291	1	2.0	*
Manufacturing	31-33	10	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	3	6.0	*
Services (except Public Safety)	51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92	13	26.0	0.4
Transportation, Warehousing & Utilities	48-49, 22	3	6.0	*
Wholesale & Retail Trade	42, 44-45	8	16.0	0.7
Total		50	100.0	0.6

[1]Sufficient information for sector groups classification was available for 50 (83.3%) cases.

[2]Rates 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.

*Rates were suppressed when the number of cases was between one and five due to statistical unreliability

Top Five NORA Sector Groups by Cause of Injury

Table 11 illustrates the top five NORA Sector Groups by cause of injury. One Cause of injury was unknown due to the individual losing consciousness and being found lying down. For all cases in the top five NORA Sector Groups, "Fall" was the predominant cause of a hospitalized intracranial injury. The percentages of fall being the predominant cause varied with Transportation, Warehousing & Utilities (100%), the Services (except Public Safety) (75.0%), and the Wholesale and Retail Trade (71.4%).

Table 11. Number of Work-Related Hospitalized Intracranial Injuries with Workers' Compensation as the Expected Payer among the Five NORA Sector Groups with the Largest Number of Intracranial Injuries , Michigan 2020 – 2021

NORA Sector Group	Struck By	Fall	Assault	MVC	Machine	Other	Medical Condition	Total
Services (except Public Safety)	2	9	0	1	0	0	0	12
Construction	5	6	1	0	0	0	0	12
Manufacturing	2	5	0	1	1	1	0	10
Wholesale & Retail Trade	0	5	0	0	0	1	1	7
Transportation, Warehousing & Utilities	0	3	0	0	0	0	0	3

MIOSHA Inspections

MIOSHA inspected two workplaces where a hospitalized intracranial injury had occurred. Both inspections were in response to a fatal intracranial injury. Both fatalities occurred in the Construction NORA sector group. MIOSHA cited both companies after finding four violations of the MIOSHA rules and assessed $28,000 in penalties. Neither of the two companies that received a citation had corrected the hazard at the time of the inspection that caused the intracranial injury.

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

- *Construction worker*

A male construction worker in his late 40s was struck by a falling crane boom that was retrofitted onto a barge. The male suffered blunt force head trauma and did not survive the impact. MIOSHA cited the company for two serious violations: Violation one 1926.1417(o)(1): CS Part 10 Cranes and Derricks. "The equipment must not be operated in excess of its rated capacity. The barge that was retrofitted with a Terex crane was not operated within its capacity; the turret failed while lifting a 4,997-pound bulkhead." The second serious violation 1926.1417(o)(1): CS Part 10 Cranes and Derricks "The employer

must ensure that each operator is trained, certified/ licensed, and evaluated in accordance with this section before operating any equipment covered under subpart CC, except for the equipment listed in paragraph (a)(2) of this section. The employer did not ensure that the sub-contractor foreman/crane operator was a certified crane operator to operate the barge crane." MIOSHA fined the workplace $14,000 for the two violations.

- Construction worker

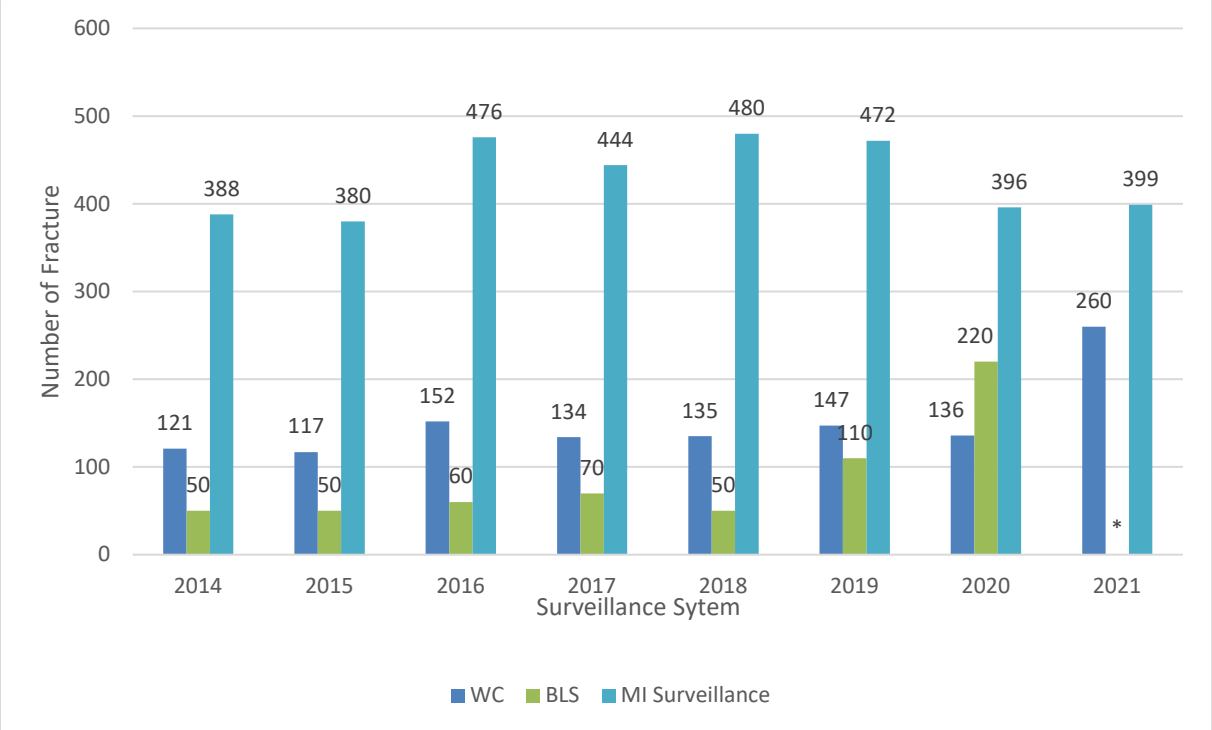
A male construction worker in his mid-20s was working on upgrades of a storm drain when he was struck by a vehicle and died after blunt force trauma to the head. MIOSHA inspected the worksite and cited the company for two serious violations. Violation one 408.42223(1):CS Part 22 Signals, Signs, Tags, and Barricades. Traffic control devices shall be installed and maintained as prescribed in Part 6 of the 2011 MMUTCD, which is adopted by reference in R 408.44209. There were no advanced warning signs or channelizing device to close the shoulder to delineate the beginning of the workspace and direct motor traffic to remain within the traveled way. REF Part 6 of the 2011 MMUTCD section 6G.07. The second serious violation was 408.40114(2)(c): CS Part 1 General Rules An accident prevention program shall at minimum, provide for all the following: (a) Instruction to each employee regarding the operating procedures, hazards, and safeguards of tools and equipment when necessary to perform the job. (b) Inspections of the construction site, tools, materials, and equipment to assure that unsafe conditions which could create a hazard are eliminated. (c) Instruction to each employee in the recognition and avoidance of hazards and the regulations applicable to his or her work environment to control or eliminate any hazard or other exposure to illness and injury. (d) Instruction to each employee who is required to handle or use poisons, toxic materials, caustics, and other harmful substances (e) Instruction to each employee if known harmful plants, reptiles, animals, or insects are present. The employer accident prevention program did not provide proper instructions to protect them from hazards associated with work being performed on the shoulder of the road of an urban multi lane freeway. The Michigan Manual of Uniform Traffic Control Devices was referenced in the accident prevention program and was not provided to employees. MIOSHA fined the workplace 14,000 dollars for the two violations.

DISCUSSION

This is the fifth report on work-related skull fractures in Michigan and the third report on hospitalized work-related intracranial injuries with Workers' Compensation as the expected payer in Michigan. Both reports cover the calendar years 2020 and 2021.

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 396 work-related skull fractures in 2020, and 399 in 2021 in comparison to 220 estimated by BLS in 2020 (Figure10). BLS has not yet released the 2021 data. The number of fatalities from a skull fracture were 18 in 2020 and two in 2021.

Figure 10. Number of Work-Related Skull Fractures in the Michigan Surveillance, BLS and Workers' Compensation Data Systems, Michigan 2020-2021



** BLS has not released skull fracture data for 2021*

For 2020, the BLS estimate for work-related skull fractures was 220, which was 55.6% of the 396 work-related skull fractures reported in the Michigan's multi-source reporting system. This estimate from BLS was significantly higher as compared to previous BLS estimates. Where BLS numbers were 110 in 2019 and 50 in 2018, the number of skull fracture fractures in 2020 was 220. It is not clear why the BLS estimate of the number of work-related skull fractures in 2020 was twice what it was in previous years. We will be watching the 2021 BLS data and future years to see if the 2020 data was an anomaly.

The BLS undercount of work-related skull fractures compared to the Michigan multi-source reporting system 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 57 self-employed individuals, and 38 farmers with work-related skull fractures in 2020 and 2021, 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 58.5% of the work-related skull fractures treated at Michigan hospital and emergency department in 2020 and 2021. Another 57 (7.2%) were not covered by workers compensation (i.e., self-employed). We do not know the reasons why workers compensation was not listed as the payor for the other 34.3% of the hospitalizations/ED visits.

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 seven or more consecutive days away from work; 2) WDCA excluded the self-employed, but again there were only fifty-seven self-employed workers; 3) Coding or miscoding errors in the WDCA data. The matching with hospital records showed that 150 work-related skull fractures between 2020 and 2021

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 2020 and 2021, thirteen 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.[13]

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 2020 and 2021, we have identified sixty 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 eighteen 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 2020-2021 skull fractures dataset and not in the intracranial injuries dataset.

Unlike most conditions, the Michigan surveillance system for intracranial injuries reported fewer injuries than those estimated in the BLS employer-based system, 60 vs. 1,330.

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 and treated in urgent care or other non-hospital settings. There were another 513 WDCA cases in 2020 and 2021 identified as concussions and only six (1.2%) matched with hospital records. There were an additional 25 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 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 14 fatalities with underlying cause of death from intracranial injuries (i.e., subdural hematoma, craniocerebral trauma, blunt head trauma). One of the 14 fatalities were identified by hospital medical records as a hospitalized case 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. Most work-related skull fractures and hospitalized intracranial injuries with Workers' Compensation as the expected payer were among men, intracranial injuries with 81.7% and skull fracture with 78.2%, and among whites, intercranial injury 61.5%and 81.9% for skull fractures. Injuries due to a fall and struck by incidents were the top two injury causes, with 71.2% for skull fractures and 80.0% 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 29.8% and 26.0% of all injuries, respectively.

The 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.

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