

# Work-Related Skull Fractures in Michigan: First Report (January 2010 – December 2011)

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**Work-Related Skull Fractures in Michigan:  
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(January 2010 – December 2011)**

A Joint Report of

**Michigan State University**

and

**Michigan Department of Licensing and Regulatory Affairs**

and

**Michigan Department of Community Health**

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# 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 first report on occupational skull fractures in Michigan; it covers the years 2010 and 2011. These are the key findings:

- Work-related skull fractures were identified through multiple reporting sources, and were often reported by more than one source:
  - There were 114 work-related skull fractures including eight deaths in 2010.
  - There were 120 work-related skull fractures including two deaths in 2011.
- The most common type of medical encounter was hospitalization (47.4% in 2010 and 41.7% in 2011).
- In both 2010 and 2011, 83.0% of all work-related skull fractures were among men.
- In 2010 84.5% of all work-related skull fractures were among Caucasians; in 2011 88.7% were among Caucasians.
- The base of the skull was the most common location of the fracture (62.3% in 2010 and 55.0% in 2011).
- The most common type of work-related skull fracture was a depressed (broken bone pushed inward) skull fracture (64.0% in 2010 and 54.2% in 2011).
- Forty-six percent of individuals in 2010 and 61.1% in 2011 lost consciousness due to the head injury.
- Three industries – Construction, Primary Metal Manufacturing and Public Administration accounted for a third of all work-related skull fractures in both years of surveillance, 33.0% and 36.8%, respectively.
- A fall was the predominant cause of injury in the Construction industry (64.3% in 2010 and 50.0% in 2011), followed by struck by injuries in the Primary Metal Manufacturing industry (46.2% in 2010 and 50.0% in 2011).
- Workers' Compensation was the expected payer in 57.1% of the 91 cases in 2010 and 57.1% of the 98 cases in 2011 that were identified in the hospital/ED records.
- There were at least another 19 nasal fractures in 2010 and 22 in 2011 that were not included in the data analysis in this report. Inclusion of these nasal fractures raises the total number of skull fractures in Michigan to 133 in 2010 and 142 in 2011. This compares to 100 and 90 skull fractures in Michigan reported from the employer based system administered by the US Department of Labor, Bureau of Labor Statistics.

## BACKGROUND

This is the first report on occupational skull fractures in Michigan. The report is based on data for 2010 and 2011. 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 much larger category of injuries to the brain 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 traumatic injuries that can occur in a workplace. A traumatic injury is “bodily damage resulting from exposure to physical agents such as mechanical energy, thermal energy, ionizing radiation, or resulting from the deprivation of basic environmental requirements such as oxygen or heat. Mechanical energy injuries include acceleration and deceleration injuries, blunt trauma, and penetrating wound injuries”.<sup>1,2</sup> 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 Community Health (MDCH) or a local health department. This work-related skull fractures 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 3,850 work-related fractures to the head in 2010 (incidence rate of 4 workers per 100,000 full-time workers), and 4,170 in 2011 (incidence rate of 4 workers per 100,000 full-time workers).<sup>3</sup> 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. BLS reported 100 work-related skull fractures for Michigan in 2010 and 90 in 2011. This corresponds to a rate of 4, and 3 per 100,000 full-time workers, respectively. (Note: The BLS estimate includes work-related nasal fractures. Nasal fractures were not reported by Michigan hospitals/EDs in 2010 and 2011 and are not included in the data for this report. Nasal fractures will be included in the 2012 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 if a case meets designated criteria, information about the employer where the skull fracture took place is referred to the Michigan Occupational Safety and Health Administration for a possible workplace investigation.

## DATA SOURCES AND METHODS

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

- Hospitals/Emergency Departments
- Workers' Compensation Agency (WCA)
- Michigan Fatality Assessment and Control Evaluation (MIFACE)<sup>4</sup>

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 were defined as any individual aged 16 years or older receiving medical treatment at a Michigan hospital/ED for whom: (a) a skull fracture-related ICD-9 diagnosis code was assigned (International Classification of Diseases, Ninth Revision)<sup>5</sup>:

- 800.0-.9 – Fracture of vault of skull,
- 801.0-.9 – Fracture of base of skull,
- 803.0-.9 – Other and unqualified skull fractures,
- 804.0-.9 – Multiple fractures involving skull or face with other bones,

and (b) the incident was documented as having occurred at work. ICD-9 code: 802.0-.9 (Fracture of face bones) was not requested because we conducted a pilot study which

showed that this code was often associated with assaults (punches to face) and not with any potential work-related fractures.

The Michigan Department of Licensing and Regulatory Affairs (LARA) and WCA 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 fracture ("Nature of Injury" code) to one of the following "Parts of Body": Brain; Cheek/Chin/Jaw/; Concussion; Face, multiple parts; Face, not elsewhere specified; Face, unspecified; Forehead; Head, multiple; Head, unspecified; Mandible; Scalp; Sinus; or Skull.

Cases identified through the MIFACE program were identified as an individual whose underlying cause of death was from a skull fracture. If the fatality is identified using hospital medical records, it is 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 code), 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 Workers' Compensation database. Matches were identified using individual's first and last name, date of birth and date of injury. Finally, WCA cases meeting the work-related skull fracture case definition that did not match with any of the other of the data sources (i.e. where WCA 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 are eliminated, after abstracting all information from every data source.

Individuals whose workplaces could not be identified in the records and met the criteria for a MIOSHA referral were contacted by telephone to obtain employer information. The criteria for the 2010 MIOSHA referrals were: 1) the individual had to be hospitalized in 2010, and 2) the skull fracture occurred in the last six months. The criteria for the 2011 MIOSHA referrals were: 1) the individual had to be hospitalized, treated in an emergency department or as an outpatient at a hospital in 2011, and 2) the skull fracture occurred in the last six months.

For cases whose employers were referred to MIOSHA, additional information was obtained about the results of the referral, including: date of referral, whether an inspection was performed, inspection date, number of violations, and total fines assessed.

Data analysis was performed using queries conducted in Microsoft Access. Skull Fracture rates by age, gender, and industry were calculated using the U.S. Census, Department of Labor's Current Population Survey for denominators.

The BLS' Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the 2010 and 2011 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.<sup>3</sup> For 2010, code 012XXX (Fractures) and code 084XXX (Fractures and other injuries) was used. For 2011, 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.



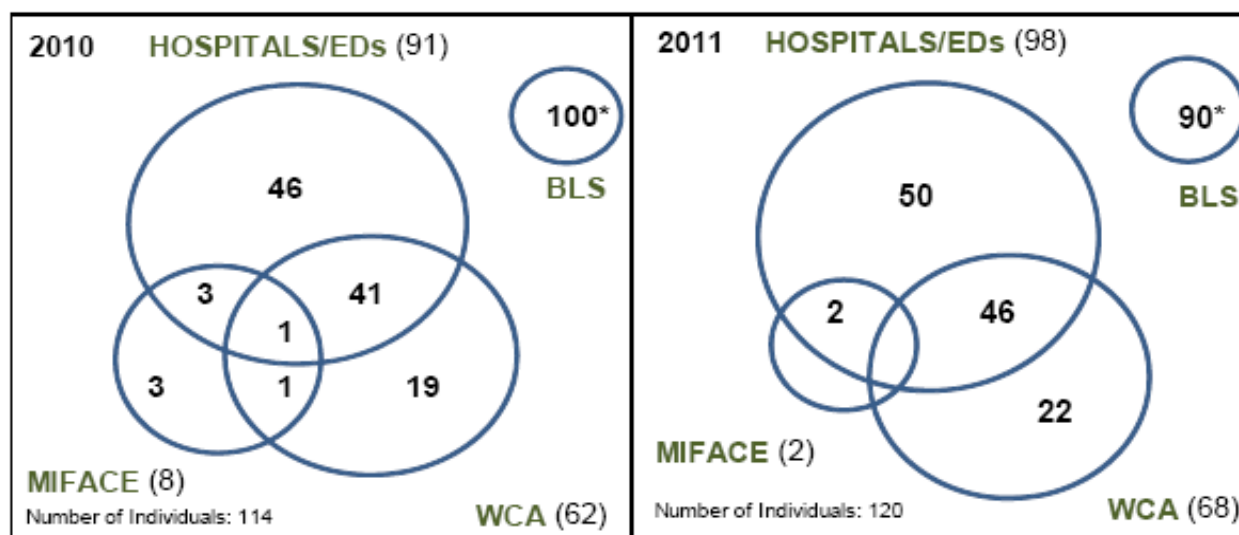
# RESULTS

In 2010, 114 individuals had a work-related skull fracture and in 2011, 120 individuals had a work-related skull fracture reported from hospital/ED, WCA, or the MIFACE.

## Reporting Sources

The number of 2010 and 2011 work-related skull fractures in Michigan by the reporting source and a comparison with the number estimated by BLS is shown in Figure1.

**Figure 1. Reporting Sources of Work-Related Skull Fractures, Michigan 2010 - 2011**



\*There is presumably overlap between the 100 (2010) and 90 (2011) estimates of the BLS and the Michigan reporting sources (HDC, MIFACE and WCA) but BLS does not allow access to their data to assess the degree of overlap. BLS estimates include nasal fractures while the hospital/ED, WCA and MIFACE totals do not.

## 2010 Reporting Sources

In 2010, Hospital/ED reports identified 91 cases, WCA 62 cases, and MIFACE 8 fatalities. Hospital/ED reports matched 41 WCA reports and 3 MIFACE reports. One skull fracture case was identified by all of the reporting sources and 1 by both WCA and MIFACE reports. The other 3 fatalities were identified through the MIFACE program only. Nineteen skull fracture cases were identified by the WCA data source only. Because of confidentiality restrictions, no attempt was made to match our data set with the BLS data set.

There were 62 WCA cases in 2010 identified as work-related skull fractures. Twenty-four were identified because they had been classified as a fracture to one of the following parts of body: Brain; Cheek/Chin/Jaw/; Concussion; Face, multiple parts; Face, not elsewhere specified; Face, unspecified; Forehead; Head, multiple; Head, unspecified; Mandible; Scalp; Sinus; or Skull. Of the 24 records, 5 matched hospital/ED records, and 19 did not match either hospital/ED or MIFACE records. The other 38 were included because they matched with names from one or more of the other data sources, although they had an injury description in the WCA database as something other than “Fracture of skull”. The descriptions in WCA for these 38 were: 13 “Multiple Injuries”, 9 “Fracture” (other than skull), 5 “Concussion”, 5 “Cut/Laceration”, 2 “Unclassified”, 1 “Amputation”, 1 “Crush/Contusion”, 1 “Ill-Defined”, and 1 “Strains/Sprains”. Matches were made based on the employee’s name, date of birth, date of injury, employee’s zip code and employer.

There were an additional 19 nasal fractures in the WCA database that were not included in our count for 2010 even though the BLS includes those types of fractures in their estimates (ICD-9 code 802.0-.9 was not requested from the Hospitals/EDs). Beginning in 2012, hospitals/EDs were required to report ICD-9 code 802.0-.9 (Fractures of face bones).

## **2011 Reporting Sources**

In 2011, Hospital/ED reports identified 98 cases, WCA 68 cases, and MIFACE 2 fatalities. Twenty-two skull fracture cases were identified by the WCA data source only.

There were 68 WCA cases in 2011 identified as work-related skull fractures. Thirty-four were identified because they had been classified as a fracture to one of the following parts of body: Brain; Cheek/Chin/Jaw/; Concussion; Face, multiple parts; Face, not elsewhere specified; Face, unspecified; Forehead; Head, multiple; Head, unspecified; Mandible; Scalp; Sinus; or Skull. Of the 34 records, 12 matched hospital/ED records, and 22 did not match either hospital/ED or MIFACE records. The other 34 were included because they matched with names from one or more of the other data sources, although they had an injury description in the WCA database as something other than “Fracture of skull”. The descriptions in WCA for these 34 were: 12 “Multiple Injuries”, 11

“Fracture” (other than skull), 4 “Cut/Laceration”, 3 “Unclassified”, 2 “Concussion”, 1 “Crush/Contusion”, and 1 “Ill-Defined”. Matches were made based on the employee’s name, date of birth, date of injury, employee’s zip code and employer.

There were an additional 22 nasal fractures in the WCA database that were not included in our count for 2011 even though the BLS included those types of fractures in their estimates (ICD-9 code 802.0-.9 was not requested from the Hospitals/EDs). Beginning in 2012, hospitals/EDs were required to report ICD-9 code 802.0-.9 (Fractures of face bones).

Hospitalization was the most common type of hospital visit in 2010 and 2011, 54 (47.4%) and 50 (41.7%) cases, respectively. The type of medical care that workers received was not available for 19 WCA cases and 4 fatalities in 2010, and for 22 WCA cases in 2011.

**Table 1. Work-Related Skull Fractures by the Type of Medical Encounter, Michigan 2010 - 2011**

Medical Encounter Type	2010		2011	
	Number	Percent	Number	Percent
Hospitalization	54	47.4	50	41.7
Emergency Department	34	29.8	42	35.0
Outpatient	3	2.6	6	5.0
Unknown	23	20.2	22	18.3
Total	114	100.0	120	100.0

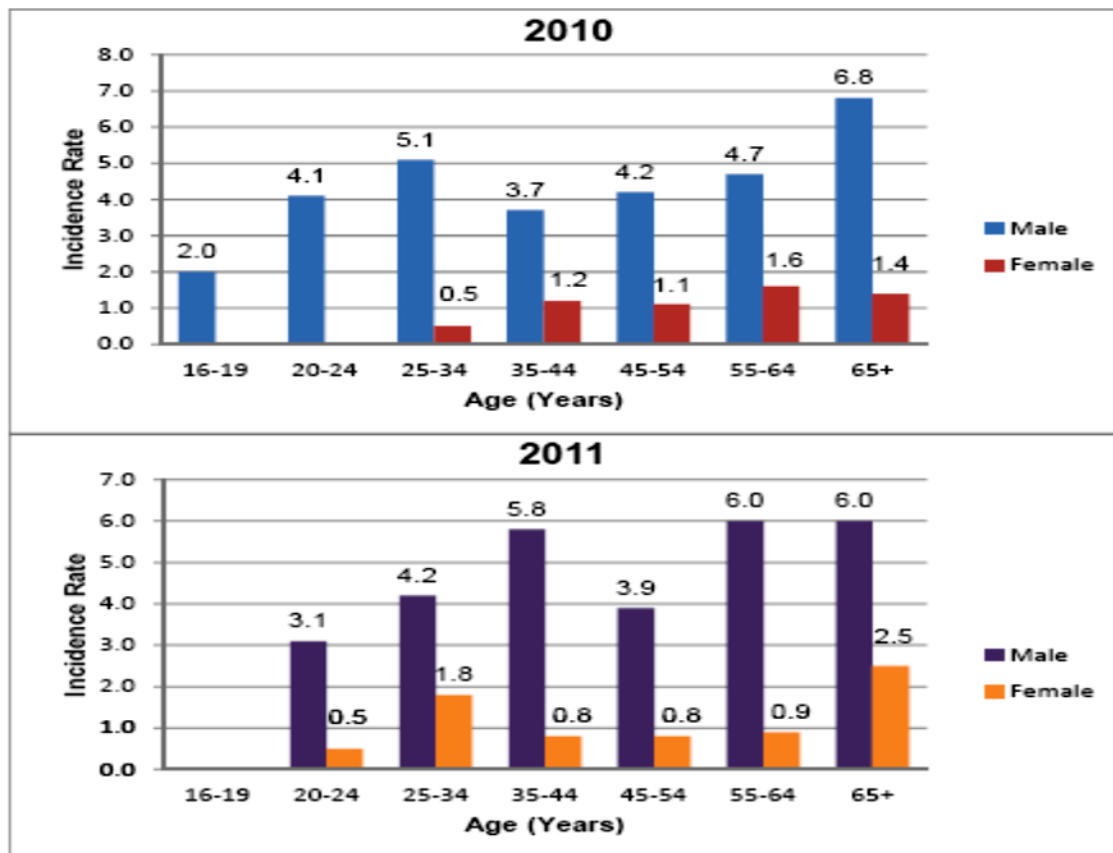
## **Characteristics of Injured Workers**

### *Age and Gender*

Age was available for all workers in 2010 and 2011. The age of injured workers ranged from 17 to 75 years in 2010 and from 21 to 72 years in 2011. The average age was 43 in 2010 and 44 in 2011. The median age was 45 in 2010 and 43 in 2011. Ninety-five (83.3%) of all work-related skull fractures in 2010 and one hundred (83.3%) of all work-related skull fractures in 2011 were among men. Figure 2 displays skull fracture rates by age group and gender. Among males, rates were highest for workers aged 65+

(6.8/100,000) in 2010 and 55-64 and 65+ (6.0/100,000) in 2011. For females, the age group with the highest rate of skull fractures was 55-64 (1.6/100,000) in 2010 and 65+ (2.5/100,000) in 2011.

**Figure 2. Work-Related Skull Fracture Rates by Age Group and Gender, Michigan 2010 - 2011\***

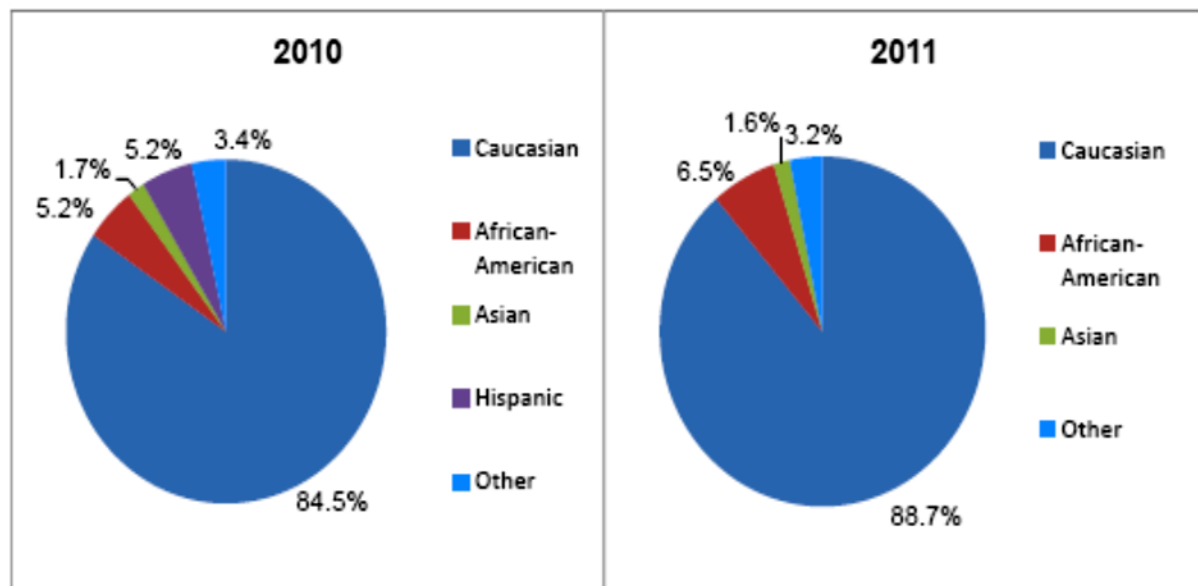


\*Rates are the number of workers sustaining a skull fracture per 100,000 workers (number of workers employed by age group used to calculate rates: Bureau of Labor Statistics' Current Population Survey).<sup>6,7</sup>

## *Race and Ethnicity*

Race and ethnicity of injured workers is shown in Figure 3. Of the workers for whom race was available (58 in 2010 and 62 in 2011), Caucasians accounted for 49 (84.5%) workers in 2010 and 55 (88.7%) workers in 2011, followed by African-Americans with 3 (5.2%) and 4 (6.5%) cases, Hispanic with 3 (5.2%) cases (only in 2010), Asians with 1 (1.7%) and 1 (1.6%) cases, and individuals whose race was classified as Other with 2 (3.4%) and 2 (3.2%), respectively for 2010 and 2011. Race and ethnicity information was unavailable for 56 (49.1%) workers in 2010 and 58 (48.3%) workers in 2011.

**Figure 3. Race/Ethnicity Distribution of Work-Related Skull Fractures, Michigan 2010 - 2011\***



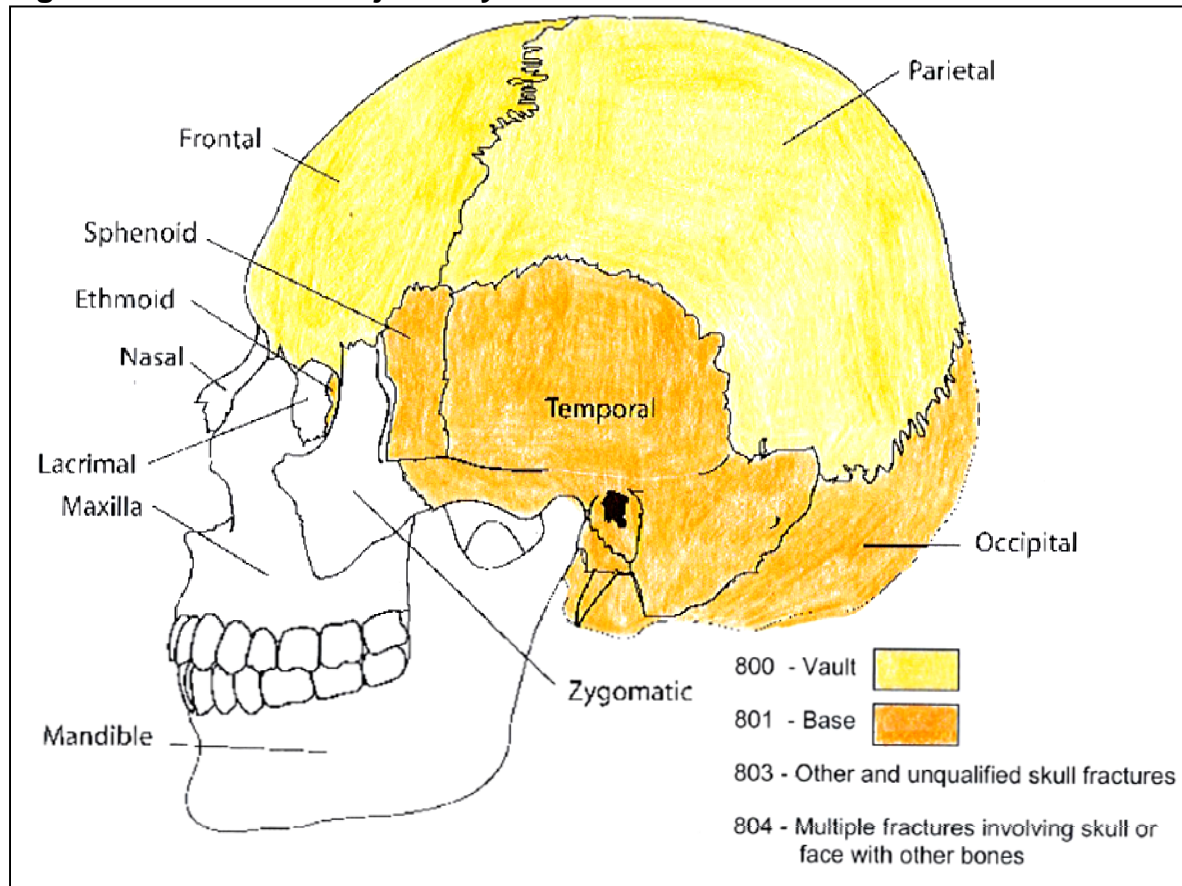
\*Race/Ethnicity information available for 58 (50.9%) individuals in 2010 and 62 (51.7%) individuals in 2011.

### *Part of Skull Injured*

Medical records specified the part of skull injured and were classified by ICD-9 codes (800.0-.9, 801.0-.9, 803.0-.9, 804.0-.9). Figure 4 illustrates parts of skull injured by ICD-9 codes. The Workers' Compensation database did not classify injuries by ICD-9 codes but did specify the part of the skull injured, which was then recoded into the ICD-9 codes.

Table 2 shows the distribution of the part of skull injured. Fractures of the base of the skull occurred most often (62.3% in 2010 and 55.0% in 2011), followed by other and unqualified skull fractures (18.4% in 2010 and 20.8% in 2011), and then fractures of the vault of the skull (10.5% in 2010 and 14.2% in 2011).

**Figure 4. Part of Skull Injured by ICD-9 Code**



**Table 2. Work-Related Skull Fractures by Part of Skull, Michigan 2010 - 2011**

Part of Skull Injured (ICD-9 Code)	2010		2011	
	Number	Percent	Number	Percent
Vault (800.0-.9)	12	10.5	17	14.2
Base (801.0-.9)	71	62.3	66	55.0
Jaw/Chin/Cheek/Face Unspecified (802.0-.9)*	8	7.0	6	5.0
Other and Unqualified (803.0-.9)	21	18.4	25	20.8
Multiple (804.0-.9)	2	1.8	6	5.0
Total	114	100.0	120	100.0

\*Fractures of Jaw/Chin/Cheek and Face Unspecified identified in the Workers' Compensation database were included in the total. ICD-9 Code: 802.0-.9 was not available from the hospital/ED source and was not included in our skull fractures surveillance program.

## *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:

- Compound Skull Fracture – a break in, or loss of, skin and splintering of the bone,
- Linear (or Hairline) Skull Fracture – a break in a cranial bone resembling a thin line, without splintering or depression of 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,
- Depressed Skull Fracture – a break in the cranial bone with depression of the bone in toward the brain.

The type of skull fracture was largely underreported. It was specified for 25 (21.9%) individuals in 2010 and 24 (20.0%) individuals in 2011. Its distribution is illustrated in Table 3. Depressed skull fractures were predominant, with 16 (64.0%) cases in 2010 and 13 (54.2%) cases in 2011. Displaced fractures accounted for 6 (24.0%) and 1 (4.2%) individuals, and linear fractures accounted for 2 (8.0%) and 10 (41.7%) individuals in 2010 and 2011, respectively.

**Table 3. Work-Related Skull Fractures by Type of Fracture, Michigan 2010 - 2011**

Type of Fracture	2010		2011	
	Number	Percent	Number	Percent
Depressed	16	64.0	13	54.2
Displaced	6	24.0	1	4.2
Linear	2	8.0	10	41.7
Compound	1	4.0	0	--
Total	25	100.0	24	100.0

\* Type of skull fracture was not specified for 89 (78.1%) individuals in 2010.

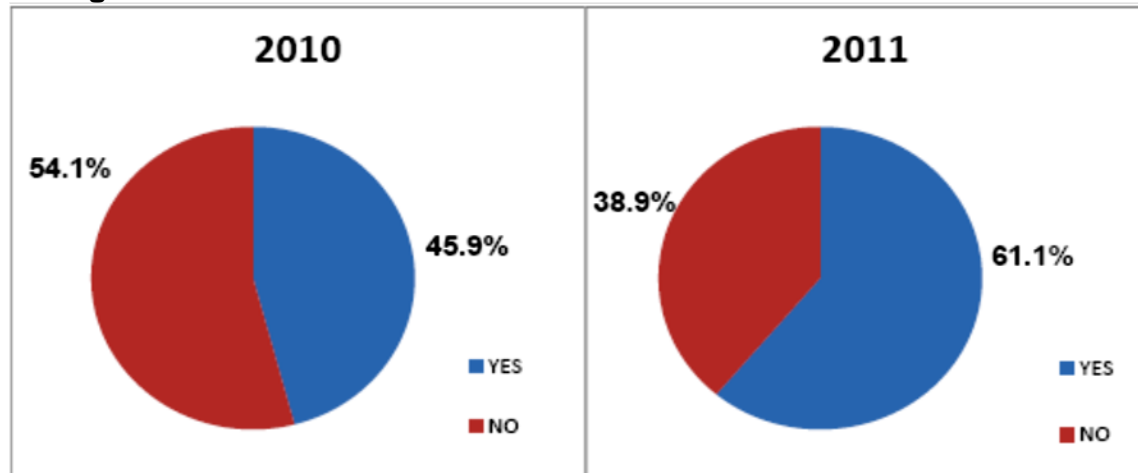
\*\* Type of skull fracture was not specified for 96 (80.0%) individuals in 2011.

## *Loss of Consciousness*

Figure 5 illustrates the percentage of individuals for whom it was recorded in the medical record whether they lost consciousness due to the injury to the head. Loss of consciousness was specified for 85 (74.6%) individuals in 2010 and 90 (75.0%) individuals in 2011. There was a 41.0% increase since the first year of surveillance in

the number of individuals who lost consciousness due to the injury to head they incurred.

**Figure 5. Work-Related Skull Fractures by Loss of Consciousness Status, Michigan 2010 - 2011\***



\*For 29 individuals in 2010 and 30 individuals in 2011 it was unknown if they lost consciousness due to the injury to head.

### *County of Residence*

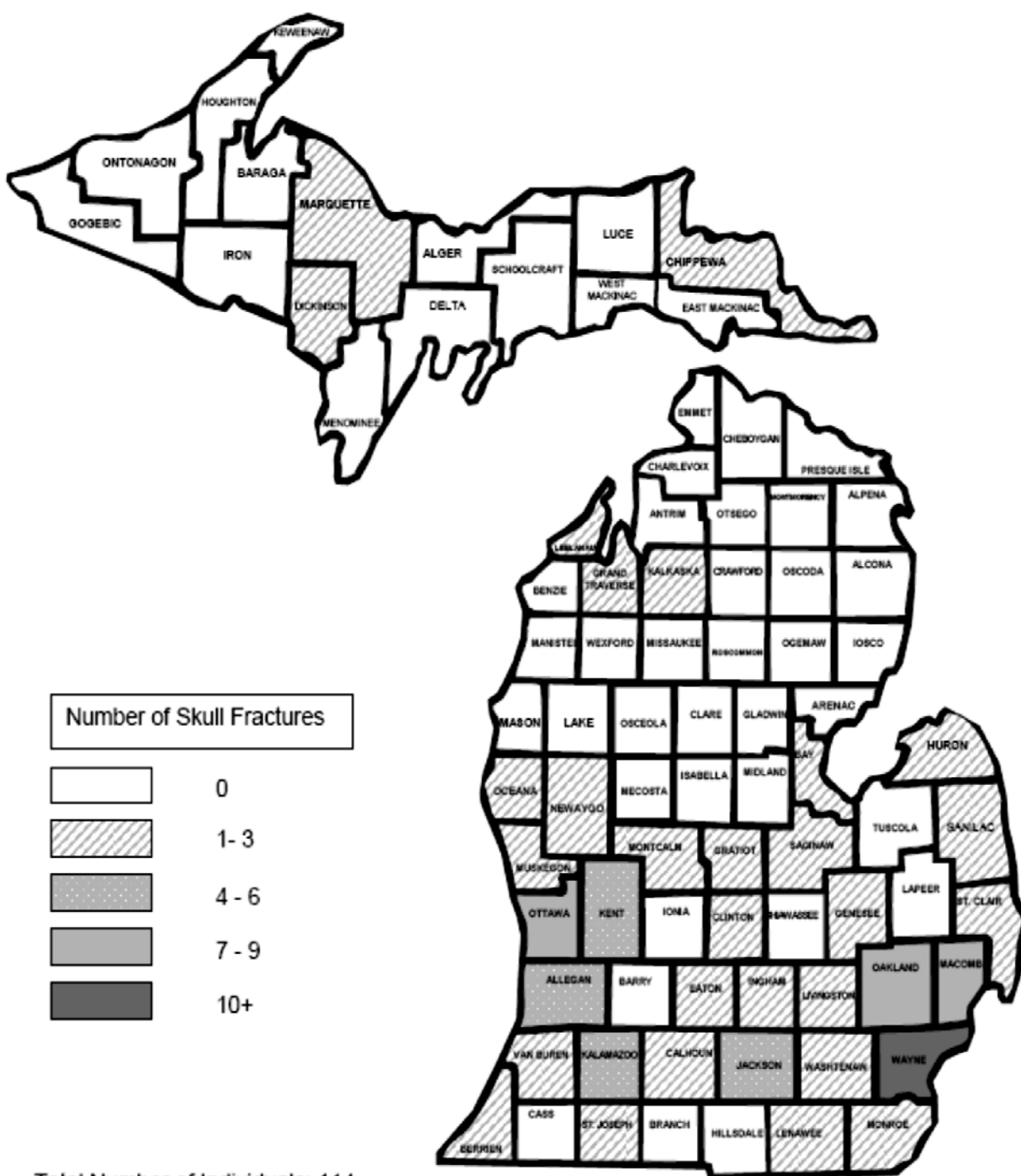
Table 4 and Figures 6 and 7 illustrate the worker's county of residence. There were 110 Michigan residents in 2010 (96.5%) and 114 (95.0%) Michigan residents in 2011 for whom the county of residence was known. There were 3 out-of-state workers in 2010 and 5 out-of-state workers in 2011. County of residence was unknown for one Michigan resident each in 2010 and in 2011. It should be noted that the county of residence would not necessarily be the same county where the individual was injured. In 2010, Wayne County had the highest number of residents with a work-related skull fracture with 18 (15.8%) cases, followed by 8 (7.0%) cases each in Oakland and Ottawa counties. In 2011, Wayne County had the highest number of residents with a work-related skull fracture with 17 (14.2%) cases, followed by Macomb with 16 (13.3%) cases.



**Table 4. Work-Related Skull Fractures by County of Residence, Michigan 2010 - 2011**

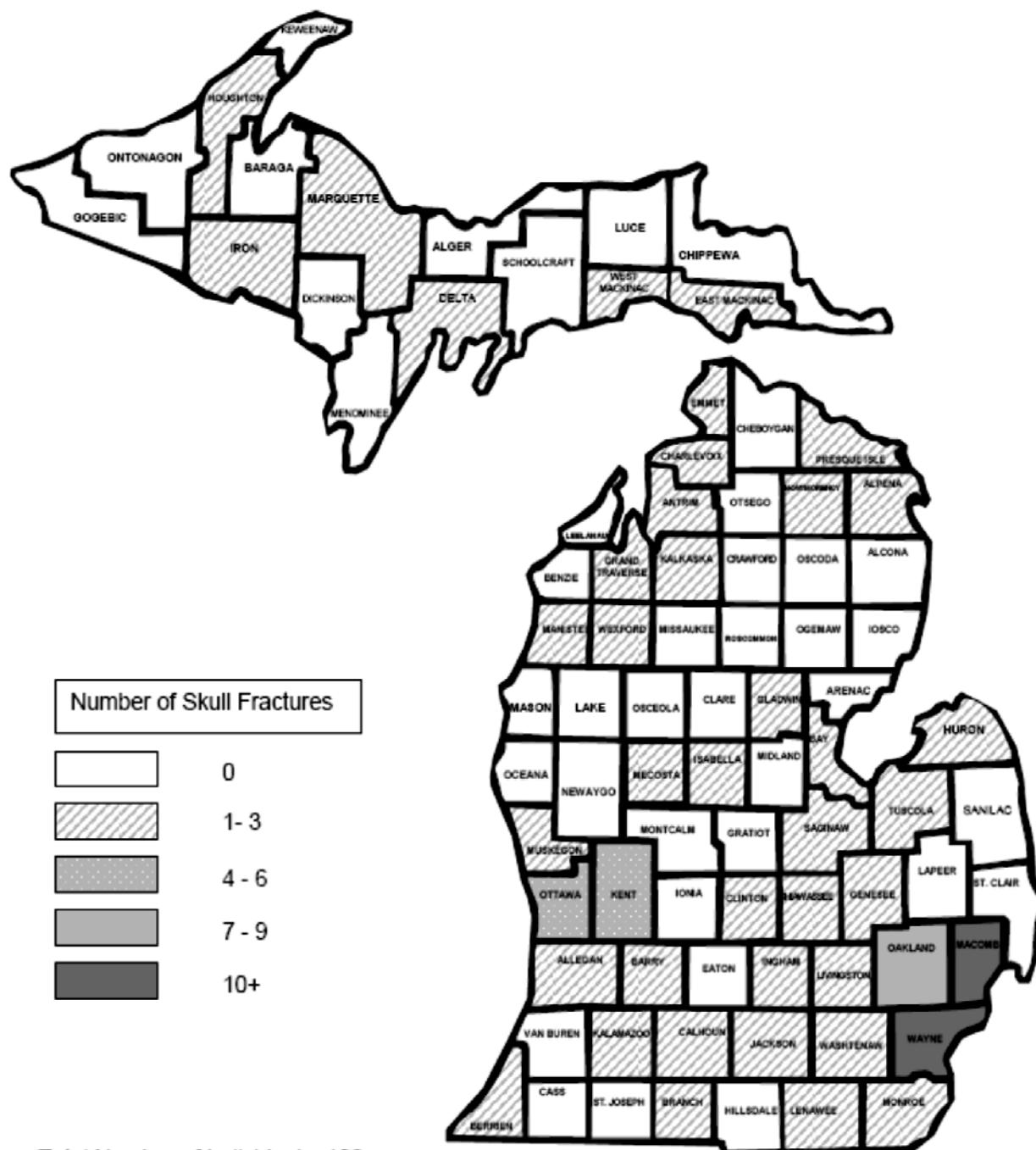
County	2010		2011		County	2010		2011	
	Number	Percent	Number	Percent		Number	Percent	Number	Percent
Alcona	0	--	0	--	Leelanau	1	0.9	0	--
Alger	0	--	0	--	Lenawee	2	1.8	2	1.7
Allegan	4	3.5	3	2.5	Livingston	2	1.8	2	1.7
Alpena	0	--	1	0.8	Luce	0	--	0	--
Antrim	0	--	1	0.8	Mackinac	0	--	1	0.8
Arenac	0	--	0	--	Macomb	7	6.1	16	13.3
Baraga	0	--	0	--	Manistee	0	--	1	0.8
Barry	0	--	1	0.8	Marquette	1	0.9	1	0.8
Bay	2	1.8	2	1.7	Mason	0	--	0	--
Benzie	0	--	0	--	Mecosta	0	--	2	1.7
Berrien	2	1.8	1	0.8	Menominee	0	--	0	--
Branch	0	--	1	0.8	Midland	0	--	0	--
Calhoun	2	1.8	3	2.5	Missaukee	0	--	0	--
Cass	0	--	0	--	Monroe	3	2.6	2	1.7
Charlevoix	0	--	2	1.7	Montcalm	1	0.9	0	--
Cheboygan	0	--	0	--	Montmorency	0	--	1	0.8
Chippewa	3	2.6	0	--	Muskegon	3	2.6	2	1.7
Clare	0	--	0	--	Newaygo	1	0.9	0	--
Clinton	1	0.9	1	0.8	Oakland	8	7.0	8	6.7
Crawford	0	--	0	--	Oceana	2	1.8	0	--
Delta	0	--	2	1.7	Ogemaw	0	--	0	--
Dickinson	1	0.9	0	--	Ontonagon	0	--	0	--
Eaton	2	1.8	0	--	Osceola	0	--	0	--
Emmet	0	--	1	0.8	Oscoda	0	--	0	--
Genesee	2	1.8	2	1.7	Otsego	0	--	0	--
Gladwin	0	--	1	0.8	Ottawa	8	7.0	6	5.0
Gogebic	0	--	0	--	Presque Isle	0	--	1	0.8
Grand Traverse	2	1.8	1	0.8	Roscommon	0	--	0	--
Gratiot	1	0.9	0	--	Saginaw	2	1.8	1	0.8
Hillsdale	0	--	0	--	Saint Clair	2	1.8	1	0.8
Houghton	0	--	2	1.7	Saint Joseph	2	1.8	0	--
Huron	1	0.9	2	1.7	Sanilac	2	1.8	0	--
Ingham	2	1.8	2	1.7	Schoolcraft	0	--	0	--
Ionia	0	--	0	--	Shiawassee	0	--	2	1.7
Iosco	0	--	0	--	Tuscola	0	--	2	1.7
Iron	0	--	1	0.8	Van Buren	1	0.9	0	--
Isabella	0	--	1	0.8	Washtenaw	3	2.6	3	2.5
Jackson	5	4.4	1	0.8	Wayne	18	15.8	17	14.2
Kalamazoo	4	3.5	3	2.5	Wexford	0	--	1	0.8
Kalkaska	1	0.9	1	0.8	Out of State	3	2.6	5	4.2
Kent	6	5.3	6	5.0	Unknown	1	0.9	1	0.8
Keweenaw	0	--	0	--					
Lake	0	--	0	--					
Lapeer	0	--	0	--	Total	114	100.0	120	100.0

**Figure 6 Work-Related Skull Fractures by County of Residence, Michigan 2010**



Total Number of Individuals: 114  
 Out of State Individuals: 3  
 County was unknown for one individual.

**Figure 7 Work-Related Skull Fractures by County of Residence, Michigan 2011**



Total Number of Individuals: 120  
Out of State Individuals: 5  
County was unknown for one individual.

## *Industry*

Table 5 describes work-related skull fractures by industry using 2-digit NAICS codes. For 109 (95.6%) individuals in 2010 and 106 (88.3%) individuals in 2011, there was sufficient information for industry classification using the North American Industry Classification System (NAICS) codes. Seven workers in 2010 and six workers in 2011 were self-employed. Construction (NAICS: 23) had the highest number of work-related skull fractures in 2010 with 14 (12.8%) cases and in 2011 with 16 (15.1%) cases, followed by the Primary Metal Manufacturing sector (NAICS: 33), which had 13 (11.9%) skull fractures in 2010 and 12 (11.3%) skull fractures in 2011, and the Public Administration sector (NAICS: 92) with 9 (8.3%) skull fractures in 2010 and 11 (10.4%) skull fractures in 2011. These three sectors combined accounted for one third of all work-related skull fractures for both years of surveillance, representing 33.0% and 36.8% of skull fractures cases, respectively. The Agriculture, Forestry, Fishing and Hunting industry (NAICS: 11) had the highest rate of skull fractures in 2010 with 10.4 per 100,000 workers. Construction industry (NAICS: 23) had the highest rate of work-related skull fractures in 2011 with 7.2 per 100,000 workers.

**Table 5. Work-Related Skull Fractures by Industry, Michigan 2010 - 2011\***

Industry Classification (NAICS)	2010			2011		
	Number	Percent	Rate	Number	Percent	Rate
Construction (23)	14	12.8	7.0	16	15.1	7.2
Primary Metal Manufacturing (33)	13	11.9	2.7 <sup>1</sup>	12	11.3	2.7 <sup>1</sup>
Public Administration (92)	9	8.3	6.2	11	10.4	7.0
Transportation and Warehousing (48)	8	7.3	8.0	6	5.7	6.6
Health Care and Social Assistance (62)	8	7.3	1.2	9	8.5	1.4
Educational Services (61)	7	6.4	1.7	3	2.8	0.7
Agriculture, Forestry, Fishing and Hunting (11)	7	6.4	10.4	1	0.9	1.5
Retail Trade (44)	6	5.5	1.8 <sup>2</sup>	8	7.5	2.7 <sup>2</sup>
Accommodation and Food Services (72)	6	5.5	2.1	2	1.9	0.6
Admin. and Support and Waste Mgt and Remediation Services (56)	6	5.5	3.6	6	5.7	3.9
Wood Product Manufacturing (32)	5	4.6	4.5 <sup>1</sup>	5	4.7	4.3 <sup>1</sup>
Wholesale Trade (42)	4	3.7	4.6	6	5.7	7.0
Finance and Insurance (52)	3	2.8	1.9	0	--	--
Utilities (22)	3	2.8	8.5	1	0.9	2.8
Real Estate and Rental and Leasing (53)	3	2.8	4.0	1	0.9	1.6
Professional, Scientific and Technical Services (54)	3	2.8	1.3	2	1.9	0.9
Food Manufacturing (31)	1	0.9	1.9 <sup>1</sup>	3	2.8	5.4 <sup>1</sup>
Sporting Goods, Hobby, Book and Music Stores (45)	1	0.9	0.7 <sup>2</sup>	2	1.9	1.3 <sup>2</sup>
General Warehousing and Storage (49)	1	0.9	2.2	1	0.9	2.5
Information (51)	1	0.9	1.2	2	1.9	2.5
Other Services (except Public Administration) (81)	0	--	--	5	4.7	2.5
Arts, Entertainment, and Recreation (71)	0	--	--	4	3.8	5.2
<b>Total</b>	109	100.0		106	100.0	

\*Sufficient information for industry classification: 109 individuals in 2010 and 106 individuals in 2011. Rates are the number of workers sustaining a skull fracture per 100,000 workers (number of workers by industry used to calculate rates: Bureau of Labor Statistics' Current Population Survey).<sup>8</sup>

<sup>1</sup> Rates do not include "Not specified manufacturing industries (Part of 31, 32, and 33)".

<sup>2</sup> Rates do not include "Not specified retail trade (Part of 44, 45)".

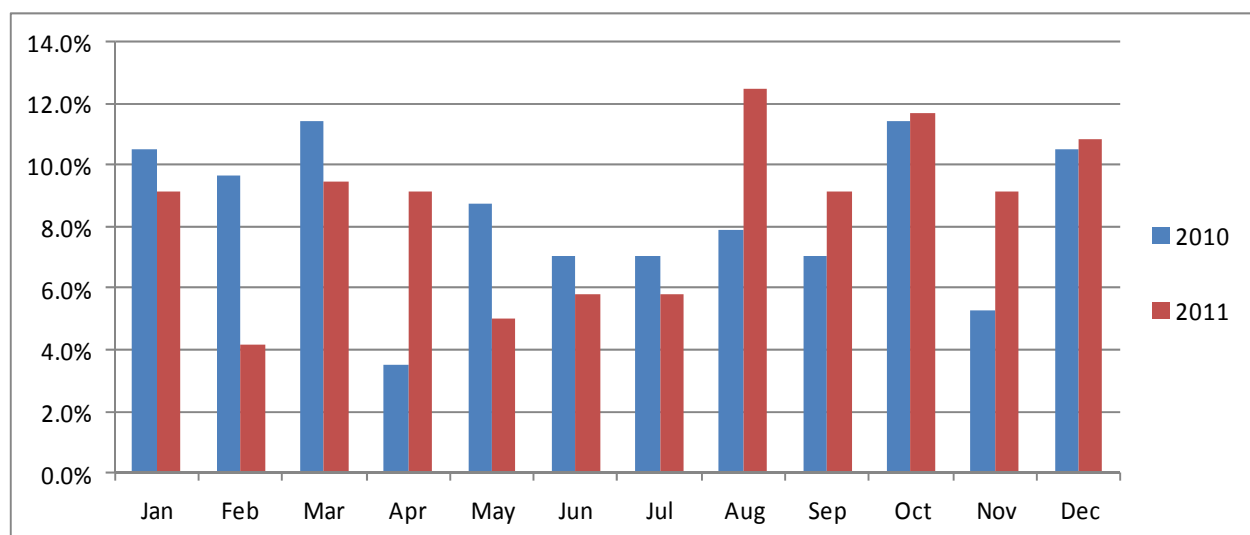
## Month of Injury

Month of injury was known for all individuals in 2010 and 2011 (Table 6 and Figure 8). The most common months for a skull fracture in 2010 occurred in March and October, each with 13 (11.4%) cases, and in 2011 in August, with 15 (12.5%) cases. The lowest numbers in 2010 were in April, 4 (3.5%) and in 2011 in February, 5 (4.2%).

**Table 6. Work-Related Skull Fractures by Month of Injury, Michigan 2010 - 2011**

Month of Injury	2010		2011	
	Number	Percent	Number	Percent
January	12	10.5	11	9.2
February	11	9.6	5	4.2
March	13	11.4	9	9.5
April	4	3.5	11	9.2
May	10	8.8	6	5.0
June	8	7.0	7	5.8
July	8	7.0	7	5.8
August	9	7.9	15	12.5
September	8	7.0	11	9.2
October	13	11.4	14	11.7
November	6	5.3	11	9.2
December	12	10.5	13	10.8
Total	114	100.0	120	100.0

**Figure 8. Percentage of the Work-Related Skull Fractures by Month of Injury, Michigan 2010 - 2011**



## Source of Payment

Workers' Compensation was the expected payer in 52 (57.1%) of the 91 cases for which there was a medical record in 2010 and in 56 (57.1%) of the 98 cases for which there was a medical record in 2011 (Table 7). For 15 cases both in 2010 and 2011, payment source could not be identified. Of the 39 cases for which Workers' Compensation was not listed as a payment source in medical records in 2010, 12 were matched to a case in the Workers' Compensation claims database. Of those 12 cases, 2 were classified as a skull fracture and 10 had an injury description in the WCA database as something other than "skull fracture". Of the 42 cases for which Workers' Compensation was not listed as a payment source in medical records in 2011, 14 were matched to a case in the Workers' Compensation claims database. Of those 14 cases, 4 were classified as a skull fracture and 10 had an injury description in the WCA database as something other than "skull fracture".

**Table 7. Work-Related Skull Fractures by Payment Source, Michigan 2010 - 2011**

Expected Source of Payment	2010		2011	
	Number	Percent	Number	Percent
Workers' Compensation	52	57.1	56	57.1
Commercial Insurance	12	13.2	8	8.2
Self Pay	10	11.0	11	11.2
Other	2	2.2	8	8.2
Not Specified	15	16.5	15	15.3
Total	91	100.0	98	100.0

Data Source: Michigan hospital/ED medical records

## Cause of Injury

Skull fractures are caused by an injury to the head and commonly occur in these situations:

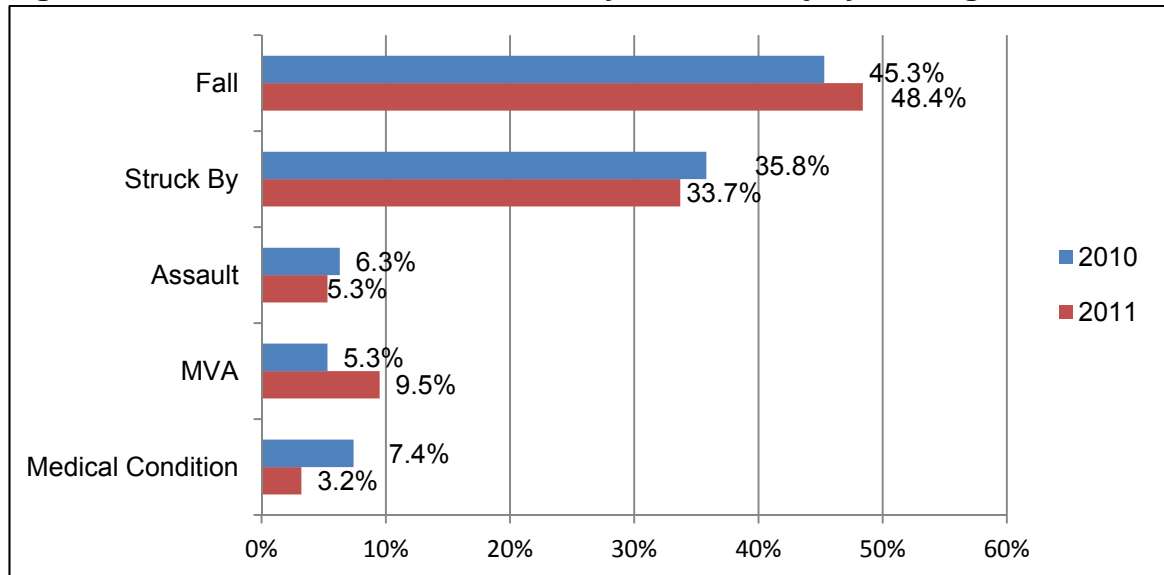
- Fall – While climbing a ladder, working on a roof or scaffolding; can be to the same level or to a lower level.
- Struck By – Falling objects, e.g. while being beneath cranes that move loads or scaffolds; flying objects, e.g. when power tools may cause objects to become airborne; struck by a truck or car; hit by an animal.

- Motor Vehicle Accident (MVA) – Occurs when a vehicle collides with another vehicle, pedestrian, animal, or some stationary obstruction, e.g. a tree or utility pole.
- Assault – Occurs when somebody is intentionally hit in the head.
- Medical Condition – Can lead to a transient loss of consciousness and postural tone, otherwise known as syncope or fainting.

The cause of injury was specified for 95 (83.3%) workers in 2010 and 95 (79.2%) workers in 2011 (Figure 9). It was unknown for 19 workers in 2010 and 25 workers in 2011. The predominant cause of injury was fall in 43 (45.3%) workers in 2010 and 46 (48.4%) workers in 2011, followed by struck by incident in 34 (35.8%) workers in 2010 and 32 (33.7%) workers in 2011, assault in 6 (6.3%) workers in 2010 and 5 (5.3%) workers in 2011, motor vehicle accident in 5 (5.3%) workers in 2010 and 9 (9.5%) workers in 2011, and medical condition in 7 (7.4%) workers in 2010 and 3 (3.2%) workers in 2011. Skull fractures due to fall and struck by incidents accounted for more than 80% of all injuries in 2010 and 2011 combined. When the industry was specified, the Construction industry had the highest percentage of injuries due to a fall with 9 (9.5%) cases in 2010 and 8 (8.4%) cases in 2011 (Table 8 and Table 9), followed by 6 (6.3%) cases each of struck by incidents in 2010 and in 2011 that occurred in the Primary Metal Manufacturing industry. Among hospitalized individuals, fall was the cause of injury for 32 (59.3%) cases in 2010 and 28 (56.0%) cases in 2011, followed by struck by for 14 (25.9%) cases in 2010 and 13 (26.0%) cases in 2011. Of eight fatalities in 2010, three were caused by a fall, another three from motor vehicle accidents, and two from being struck by an object. In 2011, two individuals died from a fall.



**Figure 9. Work-Related Skull Fracture by Cause of Injury, Michigan 2010 - 2011\***



\*Cause of injury was specified for 95 individuals each in 2010 and 2011.

### *Top Five Industries by Cause of Injury*

Tables 8 and 9 illustrate top five industries each year separately by cause of injury. Of the five, the top three industries, Construction, Primary Metal Manufacturing, and Public Administration, were common to both years and had the highest number of injuries in the first two years of surveillance. “Fall” was the predominant cause of injury within the Construction industry (64.3% in 2010 and 50.0% in 2011). Falls in the Primary Metal Manufacturing industry accounted for the other half of the skull fractures in 2011, with 6 (50.0%) of cases. “Struck by” incidents in the Primary Metal Manufacturing sector accounted for 6 (46.2%) of all skull fractures in 2010 and 6 (50.0%) in 2011. The “medical condition” category includes individuals who sustained an injury due to syncope at work.

**Table 8. Top Five Industries by Cause of Injury, Michigan 2010**

<b>INDUSTRY (ICD-9 code)</b>	<b>Fall</b>	<b>Struck By</b>	<b>Assault</b>	<b>MVA</b>	<b>Medical Condition</b>	<b>Unknown</b>	<b>TOTAL</b>
Construction (23)	9	2	0	1	0	2	14
Primary Metal Manufacturing (33)	4	6	0	0	2	1	13
Public Administration (92)	0	4	1	0	1	3	9
Transportation and Warehousing (48)	1	4	1	1	0	1	8
Health Care and Social Assistance (62)	3	1	0	0	0	4	8

**Table 9. Top Five Industries by Cause of Injury, Michigan 2011**

<b>INDUSTRY (ICD-9 code)</b>	<b>Fall</b>	<b>Struck By</b>	<b>Assault</b>	<b>MVA</b>	<b>Medical Condition</b>	<b>Unknown</b>	<b>TOTAL</b>
Construction (23)	8	4	1	0	0	3	16
Primary Metal Manufacturing (33)	6	6	0	0	0	0	12
Public Administration (92)	0	3	2	4	0	2	11
Health Care and Social Assistance (62)	1	1	1	0	1	5	9
Retail Trade (44)	4	3	0	0	0	1	8

## Referrals to MIOSHA

MIOSHA inspected 2 workplaces where fatalities occurred in 2010 and 9 workplaces where non-fatal skull fracture injuries occurred in 2011. Table 10 illustrates the distribution of violations and penalties assessed by the industry type of the eleven inspected workplaces.

**Table 10. Workplaces Inspected by MIOSHA: Violations and Penalties Assessed by Industry, Michigan 2010 - 2011**

Industry Type (NAICS)	Number of Violations	Total Penalties Assessed
All Other Misc. Chemical Product and Preparation Manuf. (325998)*	1	\$1,500.00
General Warehousing and Storage (493110)*	1	\$100.00
Roofing Contractors (238160)	6	\$40,000.00
Steel Foundries (except Investment) (331513)	3	\$7,650.00
Lumber, Plywood, Millwork, and Wood Panel Merchant Wholesalers (423310)	24	\$4,700.00
Tire Dealers (441320)	5	\$4,000.00
Fitness and Recreational Sports Centers (713940)	1	\$4,000.00
Golf Courses and Country Clubs (713910)	2	\$600.00
Water and Sewer Line and Related Structures Construction (237110)	1	--
All Other Nonmetallic Mineral Mining (212399)	0	--
Plastics Bottle Manufacturing (326160)	0	--

\*Fatality

## *Narratives: Work-Related Skull-Fracture MIOSHA Enforcement Inspections*

- *All Other Miscellaneous Chemical Product and Preparation Manufacturing:* A male in his mid-sixties, who was a truck driver, was pinned between an excavator and a semi-truck. The deceased's trailer was being loaded with tires at a private scrap yard. The operator of the excavator rotated his machine to load tires and the driver of the semi-tractor who was walking between his trailer and the excavator was crushed against the truck by the excavator's counter weight. MIOSHA cited the company for not notifying MIOSHA of a workplace fatality within 8 hours of the occurrence of the fatality.
- *General Warehousing and Storage:* A male in his mid-seventies fell from a ladder while removing a light fixture. The deceased fell from approximately 12 feet onto a concrete

floor. MIOSHA found one violation of not notifying MIOSHA of a workplace fatality within 8 hours of the occurrence of the fatality.

- Roofing Contractors: A female in her mid-twenties, who worked as a roofer, fell through a 4 foot by 4 foot roof opening. The employee fell approximately 25 feet striking some obstacles and a production welder onto a concrete floor. The employee sustained serious injuries and was hospitalized for 15 days. MIOSHA found 6 violations (one “repeat serious”, three “serious”, and two “other”), including: No warning lines and stanchions were in place on the side of the building being used as the access and exit point to the rooftop level; Employees engaged in roofing were exposed to a 4 foot by 4 foot hole that was inadequately covered; A 4 foot by 4 foot cover for a hole was not properly marked; An inadequate training program did not provide instruction to employees in the proper procedures and materials to be used when installing covers for fall protection on holes; Instructions were not provided 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 hazards or other exposure to illness or injury; No verification or written certification of fall protection training for employees engaged in roofing work exposed to falls up to 25 feet was recorded.
- Steel Foundries (except Investment): A male in his late thirties was hit by a machine’s handle as it bounced back in his face. The employee’s CAT scan showed multiple fractures of the base of the skull. The employee had to be transferred to a second hospital to receive more specialized care. MIOSHA found three “serious” violations, including: Using a hand tool that was not used only for the purpose for which it was designed or approved (employee used unapproved extension (cheater) bar to increase leverage on a chain binder handle); Not providing adequate training regarding the operating procedures, hazards, and/or safeguards of the job; Not using adequate personal protective equipment.
- Lumber, Plywood, Millwork, and Wood Panel Merchant Wholesalers: A male in his mid-forties fell off a catwalk which was approximately 5 feet of height onto the concrete below. The employee was hospitalized for two days. MIOSHA found 24 violations (13 “serious” and 11 “other”) of which one pertained to the skull fracture: An open-sided floor or

platform four feet or more above the adjacent floor or ground level was not guarded by a standard barrier on all open sides.

- *Tire Dealers:* A male in his early thirties was changing a truck tire which exploded and hit the employee in the face with a metal rim. The employee was hospitalized for 6 days. MIOSHA found 5 violations (3 “serious” and 2 “other”) including: Not maintaining a copy of Part 72, “Automotive Service Operations”, for employees’ review; Not ensuring that employees demonstrate and maintain their ability to service rims safely; Not restraining or bolting tire and wheel to vehicle while inflating; Not entering injury on Form 300 Injury and Illness Log for 2011; No Form 300A Injury and Illness Log Summary for 2011.
- *Fitness and Recreational Sports Centers:* A female in her mid-forties, who was a maintenance worker, was washing windows in the school’s aquatic center while standing in a lift basket which tipped over and the employee fell from approximately 20 feet onto a tile floor. The employee did not receive training on the operation of the lift. The employee was hospitalized for 27 days. MIOSHA found one “willful serious” violation of allowing employees to use a material lift as a manlift after Great Lakes Access Rental Company placed an “Out-of-Service” tag on the material lift; which the employer allowed a man basket to be attached.
- *Golf Courses and Country Clubs:* A male in his early thirties, whose occupation was maintenance worker, was trimming branches when a large branch fell approximately 25 feet onto the employee’s head. MIOSHA found 2 violations (one “serious” and one “other”) including: There was no assessment of the workplace to determine if hazards that necessitated the use of personal protective equipment were present, or were likely to be present; A record of the injury was not kept.
- *Water and Sewer Line and Related Structures Construction:* A male in his mid-fifties was struck in the face with a tire that had exploded. The employee was hospitalized for 4 days. MIOSHA found one violation of not saving the injury log for five years following the end of the calendar year to which the injury was related.
- *All Other Nonmetallic Mineral Mining:* A male in his mid-forties was working with heavy machinery and using an 8-pound sledgehammer which came up and hit him in the face. The employee was using the hammer and a driver to pound out a seized bushing. While

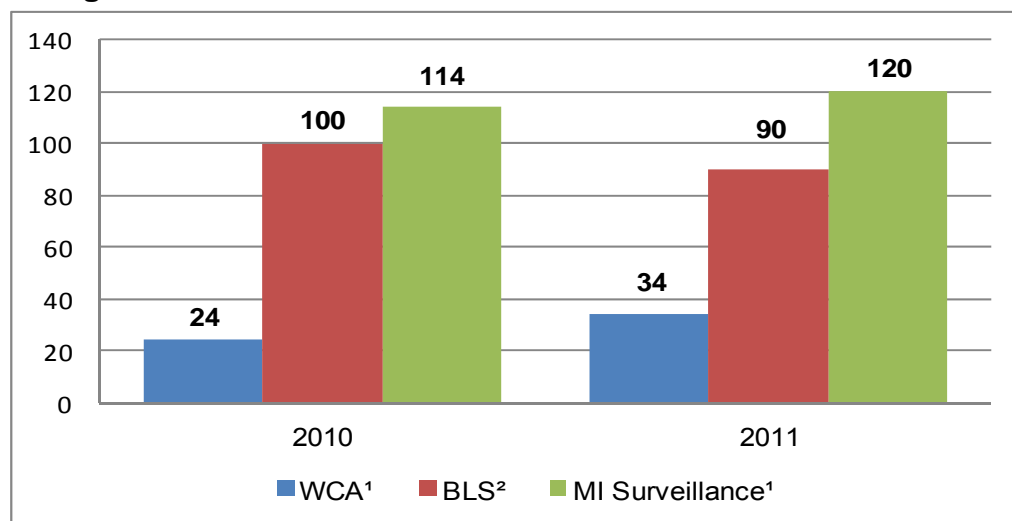
performing this operation, the employee struck the driver. The driver flew out of his hand and struck him in the face. MIOSHA found no violations of MIOSHA standards or rules.

- *Plastics Bottle Manufacturing:* A male in his late forties, whose occupation was a plastic molding machine operator, was caught in between the pneumatic operating parts of a machine. The employee was trained on machine operations and safe work procedures for molding machines. In the operator's written statement, he noticed an irregularity in the trim process that removed a tail from the bottom of the bottles. Instead of shutting the machine down to check the problem he ducked under a corner of the conveyor section, then under the machine barrier guard to watch the trim operation. During machine cycle a transfer arm returned striking him in the face and forehead pinching his head between the transfer arm and a fixed machine bracket. The employee was terminated for his actions regarding the injury as his act was a direct violation of company safety rules, policies and procedures. The employee was hospitalized for 2 days. MIOSHA found no violations of MIOSHA standards or rules.

## DISCUSSION

This is the first report on work-related skull fractures in Michigan. It covers two calendar years, 2010 and 2011. 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.<sup>9</sup> The Michigan system identified 114 work-related skull fractures in 2010 in comparison to 100 reported by BLS and 120 in 2011 in comparison to 90 reported by BLS (Figure 10). Michigan multisource surveillance and WCA's estimates do not include nasal fractures which are included in the BLS estimates. We know there were 19 nasal fractures in the WCA in 2010 and 22 in 2011. For that reason, the number of work-related skull fractures identified by the WCA and MI surveillance system would be even higher if it included nasal fractures. There was a slight increase (5.3%) in the number of all work-related skull fractures in 2011 as compared to 2010. However, the number of fatalities decreased from eight in 2010 to two in 2011.

**Figure 10. Number of Work-Related Skull Fractures by Three Surveillance Systems, Michigan 2010 - 2011**



<sup>1</sup> WCA and MI Surveillance estimates do not include nasal fractures. In 2010 there were additional 19 nasal fractures and in 2011 there were 22 nasal fractures identified by the WCA.

<sup>2</sup> BLS estimate includes nasal fractures, however it is unknown how many nasal fractures are included in the 2010 and 2011 BLS estimates.

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 fracture injuries. Secondly, the BLS excludes self-employed, independent contractors and farm workers who work on farms with less than 11 employees. Michigan's skull fracture surveillance identified only seven self-employed individuals in 2010 and six in 2011, and seven farmers in 2010 and one farmer in 2011 with skull fractures so 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.

Michigan's Workers' Compensation Agency data identified many fewer cases than the other data sources combined. Reasons contributing to the Workers' Compensation Agency undercount include: 1) The WCA data set only included skull fractures that caused 7 or more consecutive days away from work; 2) WCA excluded the self-employed, but again there were only seven self-employed workers in 2010 and six self-employed workers in 2011 in our more complete reporting system; 3) Coding or miscoding errors in the WCA data. The matching with

other data sources showed that 38 work-related skull fractures in 2010 and 34 work-related skull fractures in 2011 identified from medical records were not classified as skull fractures in the WCA data. Presumably there were other injuries in the WCA database that were similarly misclassified; 4) It is possible that some companies are handling skull fracture injuries unofficially and not reporting them to Workers' Compensation insurance companies or the WCA.

Michigan OSHA's Strategic Goal #1.3 for Fiscal Year 2009-2013<sup>10</sup> is to reduce the number of worker injuries, illnesses and fatalities in construction by focusing attention and resources on the most prevalent types of workplace injuries and illnesses; #1.3A: Decrease fatalities in the construction industry by 20% by focusing on the four leading causes of fatalities: a) Falls, b) Electrocutions, c) Struck-by, d) Crushed-by/caught-between; #1.3B: Reduce injuries and illnesses in the construction industry by 20%. 2010 and 2011 Michigan work-related surveillance identified the most skull fracture injuries in the Construction sector (12.8% in 2010 and 15.1% in 2011). Two fatalities in 2010 occurred in the Construction industry and were caused by a fall and struck by incidents. The follow back inspection of more skull fracture cases, especially in the construction sector, for an enforcement inspection may be helpful to meet this strategic goal.

Surveillance of work-related skull fractures is crucial to the recognition and prevention of these conditions. In the first year of Michigan's work-related skull fracture surveillance system, two worksites were identified by the surveillance data where a subsequent intervention by MIOSHA likely reduced skull fracture risks to other employees. The small number of MIOSHA investigations was partially limited by the delay in identifying and confirming the skull fracture before referral to MIOSHA in 2011. The number of follow up investigations in the second year of surveillance was larger (nine inspections). In 2011, skull fractures treated in a hospital, emergency department or in an outpatient clinic were eligible, whereas in 2010 only hospitalized skull fractures were. Also, hospitals were required to report every 3 months in 2011 rather than once a year which increased the timeliness of reports and efficacy of follow up investigations. Inspections generally identified major correctable problems.

Since Michigan surveillance data show patterns in the occurrence of occupational skull fractures, we plan to develop educational materials including hazard alerts where we see patterns in causes for the skull fractures. Beginning in 2012, hospitals/EDs have been reporting ICD-9 code: 802.0-.9 (Fractures of face bones), which will increase the number of skull fractures identified.



## 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:  
[http://www7.dleg.state.mi.us/orr/AdminCode.aspx?AdminCode=Department&Dpt=CH&Level\\_1=Public+Health+Administration](http://www7.dleg.state.mi.us/orr/AdminCode.aspx?AdminCode=Department&Dpt=CH&Level_1=Public+Health+Administration)
3. United States Department of Labor, Bureau of Labor Statistics' Occupational Injuries and Illnesses and Fatal Injuries Profiles, 2010. Data obtained by navigating through screens starting at the following website: <http://data.bls.gov/gqt/InitialPage>
4. Michigan Fatality Assessment and Control Evaluation available at:  
[http://www.oem.msu.edu/MiFACE\\_Program.aspx](http://www.oem.msu.edu/MiFACE_Program.aspx)
5. Public Health Services and Health Care Financing Administration. International Classification of Diseases, 9<sup>th</sup> Revision, Clinical Modification. Washington: Public Health Service, 1980.
6. U.S. Census Bureau. Employment status of the civilian noninstitutional population by sex and detailed age, 2010 annual averages available at: <http://www.bls.gov/lau/table14full10.pdf>
7. U.S. Census Bureau. Employment status of the civilian noninstitutional population by sex and detailed age, 2011 annual averages available at: <http://www.bls.gov/lau/table14full11.pdf>
8. U.S. Census Bureau. Data obtained by navigating through screens starting at the following website: <http://dataferrett.census.gov/>
9. Azaroff LS, Levenstein C, Wegman DH. Occupational Injury and Illness Surveillance: Conceptual Filters Explain Underreporting. *Am J Pub Health* 2002; 92:1421-1429
10. MIOSHA Strategic Plan FY 2009-2013 available at: [http://www.michigan.gov/lara/0,4601,7-154-11407\\_30928-37890--,00.html](http://www.michigan.gov/lara/0,4601,7-154-11407_30928-37890--,00.html)