

# Work-Related Crushing Injuries in Michigan: Fourth Report (January 2021 – December 2022)

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**May 7, 2024**

**Work-Related Crushing Injuries in Michigan:  
Fourth Report  
(January 2021 – December 2022)**

A Joint Report of

**Michigan State University**

and

**Michigan Department of Labor and Economic Opportunity**

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## EXECUTIVE SUMMARY

Michigan State University's Occupational and Environmental Medicine Division compiles data on work-related crushing injuries in the state of Michigan. This is the fourth report on occupational crushing injuries in Michigan; it covers two years, 2021 and 2022. These are the key findings:

- Work-related crushing injuries were identified through multiple reporting sources
  - In 2021, there were 1,011 work-related crushing injuries, including four deaths among 1,008 individuals.
  - In 2022, there were 948 work-related crushing injuries, including five deaths among 947 individuals.
  - Over the two years combined, there were 1,959 work-related crushing injuries among 1,949 individuals; four individuals sustained two separate crushing injuries in the same calendar year; six individuals sustained a crushing injury in 2021 and another in 2022.
- For 2021 and 2022, the U.S. Bureau of Labor Statistics (BLS) system that relies on employer reporting, estimated 680 work-related crushing injuries in Michigan or only 34.7% of the total of 1,959 crushing injuries identified in our multi-source tracking system that relies on medical records and workers' compensation data. The U.S. BLS estimated rate for Michigan was 10 per 100,000 full-time equivalent (FTE) workers between 2021 and 2022, whereas a rate of 21 per 100,000 workers of work-related crushing injuries were identified in Michigan's multi-source reporting system.
- The most common type of medical encounter for a crushing injury was an emergency department visit (1,561; 84.6%).
- Seventy-six percent of all work-related crushing injuries were among men. Among workers with information on race and ethnicity, the rates of work-related crushing injuries were 1.8 times higher for Black/African American versus White workers and 1.3 times higher for Hispanic versus non-Hispanic workers.
- The most common part of the body injured was an upper limb (1,384; 70.6%) followed by a lower limb (469; 23.9%).
- Two National Occupational Research Agenda (NORA) Sector Groups – Manufacturing and Services (except Public Safety) accounted for over a half (55.9%) of all work-related crushing injuries. Wholesale and Retail Trade accounted for another 15.6% of all work-related crushing injuries.
- Agriculture, Forestry & Fishing (except Wildland Firefighting) Sector Group had the highest rate of crushing injuries with 54.7/100,000 workers, followed by Manufacturing Sector Group with 28.1/100,000 workers.

- “Pinched between” and “Struck by falling object” were the two main causes of work-related crushing injuries with 27.1% and 21.7%, respectively.
- Workers’ Compensation was the expected payer for 68.2% of the 1,437 crushing injuries that were identified in the hospital/ED records and for which the payer type was specified.
- In 2021 and 2022, the Michigan OSHA program completed inspections at 26 worksites identified by the surveillance system as having had a crushing injury. MIOSHA issued 65 violations and assessed \$105,800 in fines. In 20 of these 26 inspections the employer had not addressed the circumstances causing the crushing injury (e.g., no guard on the machine where the crushing injury occurred) even though the MIOSHA inspection was performed months after the occurrence of the injury.

## BACKGROUND

This is the fourth report on occupational crushing injuries in Michigan. The report is based on data for 2021 and 2022. A crushing injury occurs when force or pressure is put on a body part.<sup>1</sup> This type of injury most often happens when part of the body is caught between, squeezed or put under pressure between heavy objects.

Occupational crushing injuries are among the most severe injuries that occur in the workplace. Like all workplace injuries they are potentially preventable. Michigan Department of Health and Human Services' (MDHHS) regulations define traumatic injury as a "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."<sup>2</sup> Mechanical energy injuries include "acceleration and deceleration injuries, blunt trauma, and penetrating wound injuries."<sup>2</sup> Health professionals and health facilities are required to report individuals with all injuries, including crushing injuries, regardless of cause, when requested by the Michigan Department of Health and Human Services.<sup>2</sup> The Michigan work-related crushing injuries surveillance system, based on mandatory reporting, is used to identify causes of work-related crushing injuries, target interventions to reduce crushing injuries and evaluate the effectiveness of these interventions.

The BLS, the official source of work-related injury statistics, estimated 24,670 work-related crushing injuries between 2021 and 2022 nationwide (incidence rate of 11 workers per 100,000 full-time equivalent workers).<sup>3</sup> The BLS estimates are based on employer reporting through the Survey of Occupational Injuries and Illnesses (SOII). The BLS estimate includes private industry and state and local government workers but not the self-employed or farms with fewer than 11 employees. The BLS reported 680 non-fatal work-related crushing injuries for Michigan between 2021 and 2022 (incidence rate of 10 workers per 100,000 full-time equivalent workers).

Michigan State University's College of Human Medicine, Occupational and Environmental Medicine Division operates the crushing injuries surveillance system as the bona fide agent for the State. Once a work-related diagnosis is confirmed and a case meets designated criteria, MIOSHA makes a determination whether or not to conduct a workplace investigation.

## DATA SOURCES AND METHODS

There were three reporting sources of work-related crushing injuries:

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

All 134 of Michigan's acute care hospitals, including Veterans' Administration Hospitals, were required to report work-related crushing injuries. Discharge summaries and ED notes were reviewed to differentiate the work and non-work-related crushing injuries 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) A crushing injury-related ICD-10-CM diagnosis code<sup>5</sup> was assigned as either the primary or any secondary diagnosis (Table 1), and
- (b) The incident was recorded as having occurred at work.

Some hospitals report work-related crushing injuries younger than 16 years of age.

**Table 1. Work-Related Crushing Injury ICD-10-CM Diagnosis Codes**

Code	Body part affiliated with code
S07	Head
S17	Neck
S28	Thorax, and Traumatic Amputation of Part of Thorax
S38	Abdomen, Lower Back, Pelvis and External Genitals, Including Amputation
S47	Shoulder and Upper Arm
S57	Elbow and Forearm
S67	Wrist, Hand and Fingers
S77	Hip and Thigh
S87	Lower Leg
S97	Ankle and Foot

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. A case identified using Michigan's Workers' Compensation system was defined as an individual who was in the lost work time wage replacement database with an accepted claim for a "Crush/Contusion" (WDCA's Condition Type Code 160) to any part of the body. Crushing injuries in the

WDCA cannot be distinguished from the much more common contusion injuries as both types of injuries are coded in the worker compensation database with the single code 160.

Cases identified through the MIFACE program were identified as individuals whose underlying cause of death was from a crushing injury.

Information from the hospital/ED medical reports and MIFACE reports on each case were abstracted, including: type of medical care (hospital overnight, ED, outpatient), hospital name, date of admission and discharge, patient demographics, city and county of residence, source of payment, information on whether the worker was self-employed, employer information (name, address, NAICS code), injury date, ICD code, cause of injury, side injured, digit injured, information on whether a power press injury. Once these crushing injury data were entered into a Microsoft Access database, records were manually linked to records in the Workers' Compensation database. Matches were identified using an individual's first and last name, date of birth, date of injury, and social security number when available. Information from Workers' Compensation on matched cases was added to the database. Duplicates identified by more than one reporting source were only counted once, abstracting all information from every data source. NAICS codes were converted to NORA Sector Group.<sup>6</sup>

When employer information was available, MIOSHA potentially conducted an enforcement inspection. The criteria for a MIOSHA inspection were: 1) the individual had to be hospitalized, treated in an emergency department or as an outpatient at a hospital in 2021 or 2022, 2) the injury did not occur to a self-employed individual or an individual employed by an employer not covered by Michigan OSHA (e.g., federal, railroad, merchant marine, dock or mine employee), 3) the circumstances of the injury suggested there was an ongoing hazard and 4) the crushing injury occurred in the last six months.

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

Data analysis was performed using queries conducted in Microsoft Access. The National Institute for Occupational Safety & Health (NIOSH) Employment Labor Force (ELF) Query



System, which uses BLS Current Population Survey (CPS) data, provides the estimated number of employed Michigan residents aged 16-years and older by age group, sex, industry, race, and ethnicity for 2021 and 2022.<sup>8</sup>

The BLS Occupational Injuries and Illnesses and Fatal Injuries Profiles online tool was used to generate the biennial 2021 and 2022 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>3,8</sup> Three codes were used to generate the estimates and incidence rates: 1971 (Crushing Injuries) – the code includes crushing injuries to upper and lower extremities – arm, hand, leg; 194 (Internal injuries to organs and blood vessels of the trunk) – the code includes crushing injuries involving internal organs; and 160 (Intracranial injuries, unspecified) – the code includes crushing injuries to the head.

## RESULTS

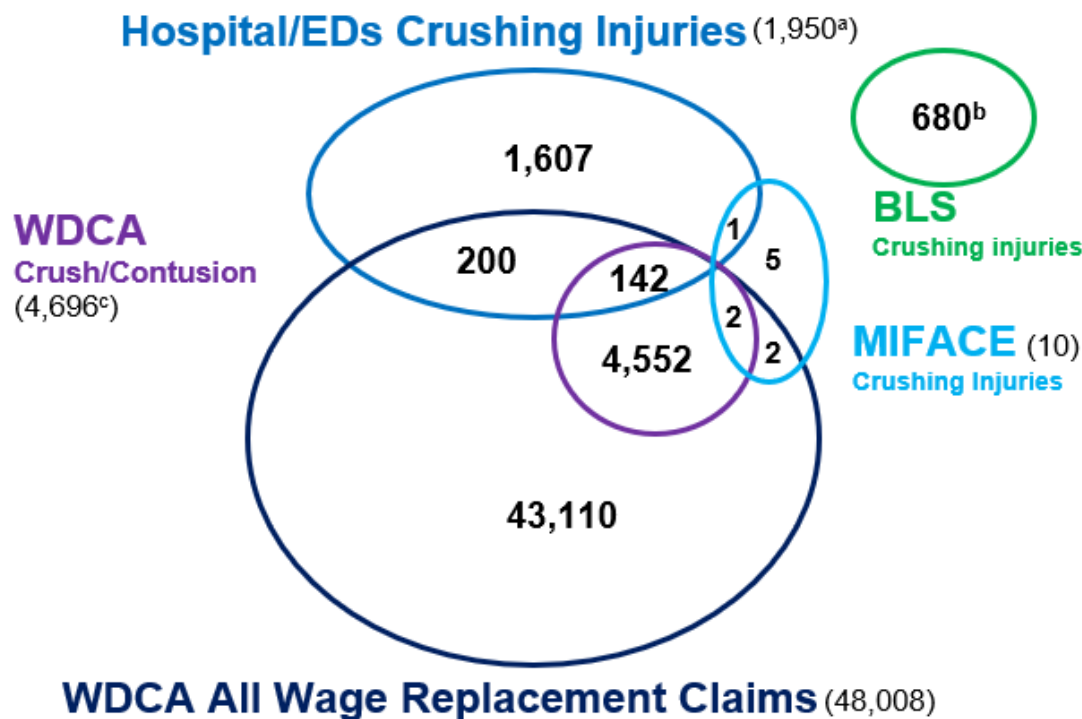
In 2021, there were 1,011 work-related crushing injuries among 1,008 individuals because three individuals sustained two separate crushing injuries in 2021. The hospitals and acute care facilities in Michigan reported for 99.2% of the quarterly reporting periods in 2021. In 2022, there were 948 work-related crushing injuries among 947 individuals because one individual sustained two separate crushing injuries in 2022. The hospitals and acute care facilities in Michigan reported for 100% of the quarterly reporting periods in 2022.

**2021-2022 Combined:** There were 1,959 work-related crushing injuries among 1,949 individuals because four individuals sustained two separate crushing injuries in the same calendar year and six individuals had one crushing injury in 2021 and another in 2022.

### Reporting Sources

The number of 2021 and 2022 work-related crushing injuries 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 Crushing Injuries, Michigan 2021–2022



<sup>a</sup>Number of Individuals: 1,949

<sup>b</sup>Crushing injuries captured by BLS may also be captured in Michigan's multi-source surveillance system, however, due to confidentiality reasons, no attempt to match the two systems was made.

<sup>c</sup>The same condition type (code 160) is used for both crushing injuries and contusions so the two cannot be differentiated in the Workers' Disability Compensation Agency database.

Hospitals/ED reports identified 1,950 cases and the MIFACE program identified nine additional cases to combine for the total number of cases captured by the Michigan surveillance system between 2021 and 2022. Hospital/ED reports matched with 142 WDCA reports of crushing and contusion injuries. One hospital/ED report matched with one MIFACE report, four MIFACE reports matched with four WDCA reports, two of which were classified as WDCA Crush/Contusion reports. Five crushing injury cases were identified by the MIFACE program only. Because of confidentiality restrictions, no attempt was made to match the Michigan data set with the BLS data set.

There were 342 injuries in the WDCA database that matched with work-related crushing injuries identified by medical records and four WDCA injuries that matched with four crushing injury fatalities identified through the MIFACE program. One hundred and forty-two hospital/ED reports were matched with the WDCA Crush/Contusion records. Although they had an injury description in the WDCA as something other than “crush/contusion” injury, 200 crushing injuries matched with personal identifiers from one or more of the hospital/ED sources. The number of cases and descriptions in WDCA for these 200 records were: 74 “Fracture”, 50 “Cut/Laceration”, 23 “Strains/Sprains”, 11 “Multiple Injuries”, 11 “Amputation”, 2 “Dislocation”, 2 “Inflam-Joints”, 1 “Concussion”, 1 “Burn (Heat)”, 1 “Hernia”, 2 “Other Injury/NEC”, 22 “Unclassified”. Matches were made based on the employee’s first and last name, date of birth, social security number, date of injury, employee’s zip code and employer information. There were another 4,552 crush/contusion injuries identified only in the WDCA database that were not included in this report as we were not able to determine if the injury was a crush or a contusion.

An emergency department visit was the most common type of medical encounter, 1,561 (79.7%) cases (Table 2).

**Table 2. Work-Related Crushing Injuries by the Type of Medical Encounter, Michigan 2021–2022\***

Medical Encounter Type	Number	Percent
Hospitalization	174	9.4
Emergency Department	1,561	84.6
Outpatient	111	6.0
<b>Total</b>	<b>1,846</b>	<b>100.0</b>

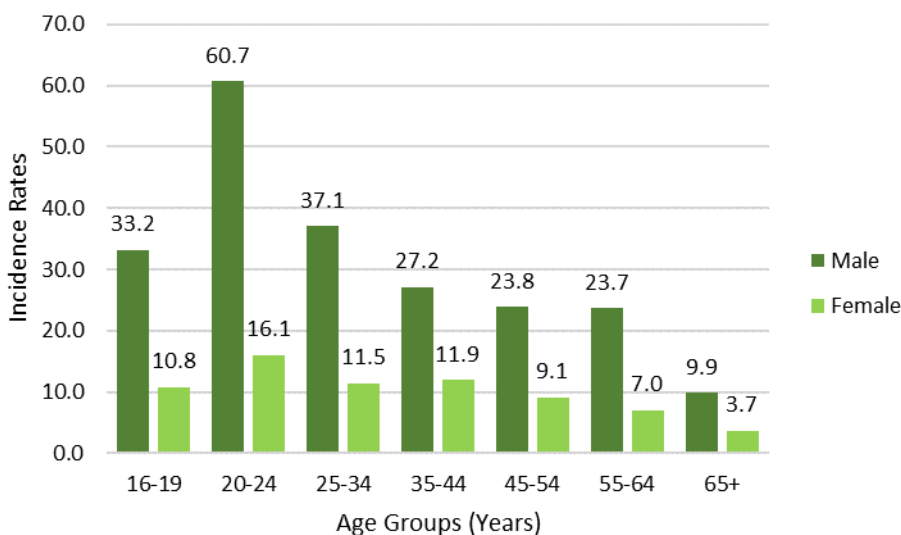
\*Information on the type of medical encounter was provided for all individuals. Medical encounter was listed as “Other” (e.g., occupational disease report from a doctor, specialty office visit, or MIFACE case with no hospital visit) for 113 individuals.

## Characteristics of Injured Workers

### Age and Sex

The age of injured workers varied from 15 to 79 years. There was only one worker who suffered a crushing injury under the age of 16 years old in the Michigan surveillance database. The average age was 38 and the median age was 35. Sex was unknown for 10 workers. One thousand four hundred and ninety (76.4%) of all work-related crushing injuries were among men. Figure 2 displays crushing injury rates by age group and sex and excludes the single 15-year-old who suffered a crushing injury in the Michigan surveillance database. Among males, rates were highest for workers in the 20-24 and 25-34 age groups, 60.7/100,000 and 37.1/100,000 workers, respectively. For females, the age group with the highest rate of crushing injury was 20-24 with 16.1/100,000 workers.

**Figure 2. Work-Related Crushing Injury Rates by Age Group and Sex, Michigan 2021–2022\***



\*Data Sources: Number of work-related crushing injuries – Michigan hospital/ED medical records, MIFACE, and WDCA; Total number of workers by age group and sex – NIOSH ELF Query System (BLS CPS).<sup>7</sup>  
Note: Rates are the number of workers sustaining a crushing injury per 100,000 workers.

### Race and Ethnicity

Among the 885 workers (45.2%) for whom the race was available, 648 (73.2%) were White, 175 (19.8%) were Black/African American, 9 (1.0%) were Asian, 4 (0.5%) were American Indian/Alaska Native, 2 (0.2%) were Native Hawaiian/Pacific Islander, and 47 (5.3%) were of another unspecified race. Crushing injury rates for Black/African American workers were 1.8 times higher than for White workers. This disparity between Black/African American and White workers would still be observed even if the

distribution of workers with crushing injuries missing information on race was the same as the racial distribution of the Michigan workforce. Individuals of different racial and ethnic backgrounds are unevenly represented in different Michigan industries and occupations.<sup>9</sup> Further work is needed to determine how these differences in place of employment and job duties may contribute to the difference found in the rate of crushing injuries.

Information on ethnicity was provided for 599 (30.6%) individuals. Of the 599 individuals, 42 individuals (7.0%) were of Hispanic origin and 557 individuals (93.0%) were not of Hispanic origin. Incidence rate for Hispanic workers was 1.3 times higher than for non-Hispanic workers.

### **Part of Body Injured**

Medical records specified the part of body injured and were classified by ICD-10-CM codes. Table 3 shows the distribution of the part of body injured. Crushing injuries of upper limbs occurred most often (70.7%), followed by crushing injuries of lower limbs (23.9%).

**Table 3. Work-Related Crushing Injuries by Part of Body Injured, Michigan 2021–2022**

Part of Body Injured	Number	Percent
Face, Scalp, Neck	6	0.3
Trunk	46	2.3
Upper Limb	1,384	70.7
Lower Limb	469	23.9
Multiple and Unspecified Sites	54	2.8
<b>Total</b>	<b>1,959</b>	<b>100.0</b>

## **County of Residence**

Table 4 and Figure 3 illustrate the worker's county of residence. There were 1,767 (92.0%) Michigan residents with crushing injuries for whom the county of residence was known. There were 39 non-Michigan residents with crushing injuries while working in Michigan, and the county was unknown for 153 Michigan residents with crushing injuries. 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 crushing injury with 285 (14.5%) cases, followed by Jackson County with 125 (6.4%) cases, and then Macomb County with 110 (5.6%) cases.

**Table 4. Work-Related Crushing Injuries by County of Residence, Michigan 2021–2022**

<b>County</b>	<b>Number</b>	<b>Percent</b>	<b>County</b>	<b>Number</b>	<b>Percent</b>
Alcona	3	0.2	Leelanau	19	0.1
Alger	0	0.0	Lenawee	30	1.0
Allegan	17	0.9	Livingston	0	1.5
Alpena	10	0.5	Luce	4	0.0
Antrim	4	0.2	Mackinac	110	0.2
Arenac	1	0.1	Macomb	0	5.6
Baraga	5	0.3	Manistee	8	0.0
Barry	6	0.3	Marquette	10	0.4
Bay	17	0.9	Mason	9	0.5
Benzie	1	0.1	Mecosta	4	0.5
Berrien	34	1.7	Menominee	15	0.2
Branch	14	0.7	Midland	1	0.8
Calhoun	58	3.0	Missaukee	27	0.1
Cass	7	0.4	Monroe	24	1.4
Charlevoix	5	0.3	Montcalm	0	1.2
Cheboygan	4	0.2	Montmorency	35	0.0
Chippewa	2	0.1	Muskegon	14	1.8
Clare	6	0.3	Newaygo	83	0.7
Clinton	32	1.6	Oakland	7	4.2
Crawford	5	0.3	Oceana	4	0.4
Delta	12	0.6	Ogemaw	3	0.2
Dickinson	37	1.9	Ontonagon	6	0.2
Eaton	20	1.0	Osceola	0	0.3
Emmet	3	0.2	Oscoda	3	0.0
Genesee	76	3.9	Otsego	26	0.2
Gladwin	3	0.2	Ottawa	3	1.3
Gogebic	4	0.2	Presque Isle	2	0.2
Grand Traverse	6	0.3	Roscommon	35	0.1
Gratiot	11	0.6	Saginaw	37	1.8
Hillsdale	13	0.7	Saint Clair	70	1.9
Houghton	3	0.2	Saint Joseph	11	3.6
Huron	14	0.7	Sanilac	1	0.6
Ingham	19	1.0	Schoolcraft	15	0.1
Ionia	21	1.1	Shiawassee	23	0.8
Iosco	2	0.1	Tuscola	29	1.2
Iron	7	0.4	Van Buren	33	1.5
Isabella	15	0.8	Washtenaw	285	1.7
Jackson	125	6.4	Wayne	7	14.5
Kalamazoo	43	2.2	Wexford	19	0.4
Kalkaska	2	0.1	Out of State	39	1.7
Kent	88	4.5	Unknown	153	12.8
Keweenaw	0	0.0	<b>Instate Total</b>	<b>1,920</b>	<b>98.0</b>
Lake	2	0.1	<b>Total</b>	<b>1,959</b>	<b>100.0</b>
Lapeer	15	0.8			





## NORA Sector Groups

For 1,234 (63.0%) cases, including 38 self-employed individuals, there was sufficient information to determine their NORA Sector Group classification (Table 5). Manufacturing Sector Group had the highest number of work-related crushing injuries with 475 (38.5%) cases, followed by Services (except Public Safety) Sector Group with 215 (17.4%) cases and then Wholesale and Retail Trade Sector Group with 193 (15.6%) cases. Agriculture, Forestry, and Fishing (except Wildland Firefighting) Sector Group had the highest rate of crushing injuries with 54.7/100,000 workers, followed by Manufacturing Sector Group with 28.1/100,000 workers.

**Table 5. Work-Related Crushing Injuries by NORA Sector Groups, Michigan 2021–2022\***

NORA Sector Group	NAICS Code	Number	Percent	Rate <sup>1</sup>
Agriculture, Forestry, & Fishing (except Wildland Firefighting)	11	54	4.4	54.7
Construction	23	116	9.4	22.5
Healthcare & Social Assistance	62, 54194, 81291	79	6.4	5.5
Manufacturing	31-33	475	38.5	28.1
Mining (except Oil & Gas Services)	21	1	0.1	--
Oil & Gas Extraction	211, 213111, 213112	1	0.1	--
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	16	1.3	15.5
Services (except Public Safety)	51-56, 61, 71-72, 81, 92	215	17.4	6.0
Transportation, Warehousing & Utilities	48-49, 22	84	6.8	16.7
Wholesale & Retail Trade	42, 44-45	193	15.6	17.0
<b>Total</b>		<b>1,234</b>	<b>100.0</b>	<b>13.5</b>

\*Sufficient information for sector groups classification was available for 1,234 (63.0%) cases.

<sup>1</sup>Rates are the number of workers sustaining a crushing injury per 100,000 workers. Rate was not calculated when number of injuries was less than five. Number of workers used to calculate rates: NIOSH ELF Query System (BLS CPS).<sup>7</sup>

For the 1,228 (62.7%) cases, including 38 self-employed individuals, there was information regarding the sex of the injured worker and sufficient information to determine NORA Sector Group classification (Table 6). Of the 949 (77.3%) male workers, Manufacturing Sector Group had the highest number of work-related crushing injuries with 391 (41.2%) cases, followed by Services (except Public Safety) Sector group with 159 (16.8%) cases and then Wholesale and Retail Trade Sector Group with 147 (15.5%) cases. For male workers, the highest rates of crushing injuries were among the Agriculture, Forestry, and Fishing (except Wildland Firefighting) Sector Group with 60.8/100,000 male workers followed by Manufacturing Sector Group with 31.1/100,000 male workers.

Of the 279 (22.7%) female workers, Manufacturing Sector Group had the highest number of work-related crushing injuries with 83 (29.8%) cases, followed by Healthcare and Social Assistance Sector Group with 58 (20.8%) cases, and then Services (except Public Safety) Sector Group with 52 (18.6%) cases. For female workers, the highest rates of crushing injuries were among the Agriculture, Forestry, and Fishing (except Wildland Firefighting) Sector Group with 40.4/100,000 female workers followed by Manufacturing Sector Group with 19.3/100,000 female workers.

**Table 6. Number and Rate of Work-Related Crushing Injuries by Sex and NORA Sector Groups, Michigan 2021–2022\***

NORA Sector Group	NAICS Code	Number		Percent		Rate <sup>1</sup>	
		Male	Female	Male	Female	Male	Female
Agriculture, Forestry, & Fishing (except Wildland Firefighting)	11	42	12	4.4	4.3	60.8	40.4
Construction	23	115	1	12.1	0.4	24.1	--
Healthcare & Social Assistance	62, 54194, 81291	21	58	2.2	20.8	7.1	5.0
Manufacturing	31-33	391	83	41.2	29.8	31.1	19.3
Mining (except Oil & Gas Services)	21	1	0	0.1	0.0	--	0.0
Oil & Gas Extraction	211, 213111, 213112	1	0	0.1	0.0	--	0.0
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	9	7	1.0	2.5	18.6	12.7
Services (except Public Safety)	51-56, 61, 71-72, 81, 92	159	52	16.8	18.6	9.3	2.7
Transportation, Warehousing & Utilities	48-49, 22	63	21	6.6	7.5	17.7	14.1
Wholesale & Retail Trade	42, 44-45	147	45	15.5	16.1	24.9	8.3
<b>Total</b>		<b>949</b>	<b>279</b>	<b>100.0</b>	<b>100.0</b>	<b>19.7</b>	<b>6.5</b>

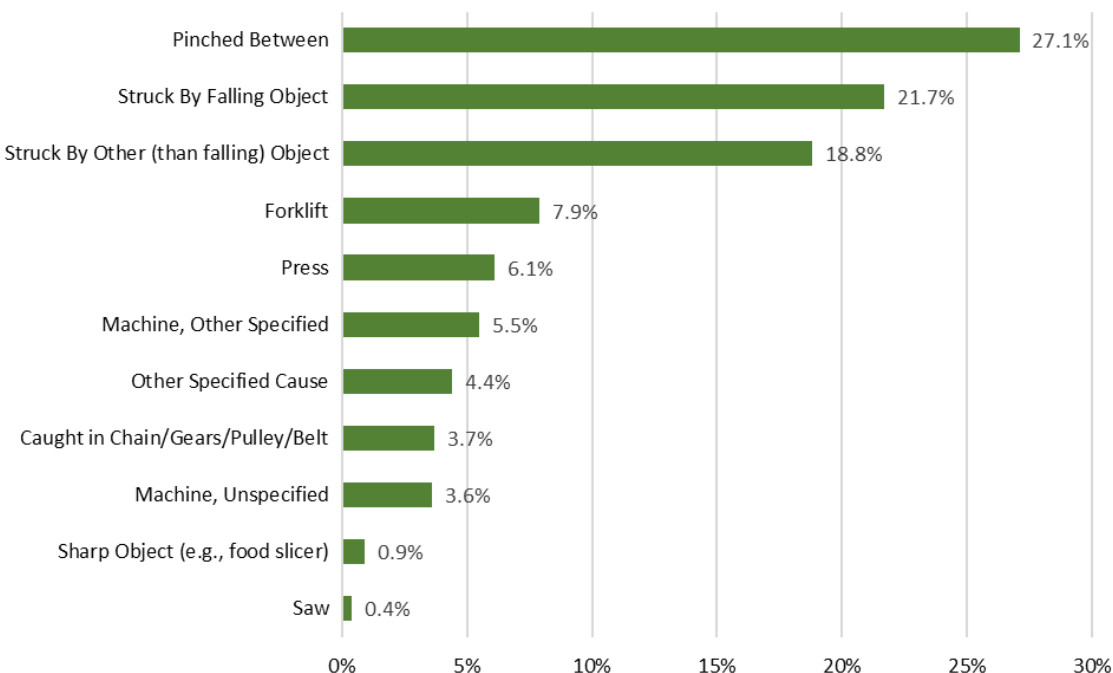
\*Sufficient information for sector groups classification and sex was available for 1,228 (62.7%) cases.

<sup>1</sup>Rates are the number of workers by sex sustaining a crushing injury per 100,000 workers by sex in the NORA sector. Rate was not calculated when number of injuries was less than five. Number of workers used to calculate rates: NIOSH ELF Query System (BLS CPS).<sup>7</sup>

## Cause of Crushing Injury

Figure 4 illustrates the cause of work-related crushing injuries. For 271 (13.8%) of the 1,959 crushing injuries, the cause of injury was not provided in the medical records. The most common cause among 1,688 crushing injuries where cause was known was “Pinched between” (objects other than door) in 458 (27.1%) cases, followed by “Struck by falling object” in 366 (21.7%). These two causes of crushing injuries accounted for almost a half of crushing injuries for which a cause was provided in medical records.

**Figure 4. Cause of Crushing Injuries, Michigan 2021–2022\***



\*Cause of Crushing Injuries was provided for 1,688 (86.2%) cases

## Source of Payment

Workers' Compensation was the expected payer in 980 (68.2%) of the 1,437 work-related crushing injuries for which there was a medical record, and the payment source was known (Table 7). For 513 (26.3%) crushing injuries payment source could not be identified. Of the 970 cases for which Workers' Compensation was not listed as a payment source in medical records, 125 were matched to a case in the Workers' Compensation claims database. Of those 125 cases, 54 were classified as a crushing injury and 71 had an injury description in the WDCA database as something other than “crushing injury”.

**Table 7. Work-Related Crushing Injuries by Payment Source, Michigan 2021–2022\***

Expected Source of Payment	All		Non-Self Employed	
	Number	Percent	Number	Percent
Workers' Compensation	980	68.2	976	69.7
Commercial Insurance	253	17.6	238	17.0
Self-Pay	39	2.7	33	2.4
Medicare/Medicaid	159	11.1	147	10.5
Other Gov't	6	0.4	5	0.4
<b>Total</b>	<b>1,437</b>	<b>100.0</b>	<b>1,399</b>	<b>100.0</b>

Data Source: Michigan hospital/ED medical records.

\*Payment source was unknown for 513 (26.3%) of all cases with a medical record (n=1,950) and for 497 (26.2%) of non-self-employed cases with a medical record (n=1,896).

## MIOSHA Inspections

MIOSHA inspected 26 workplaces where a crushing injury was identified by the surveillance system. Table 8 illustrates the distribution of violations and penalties by the NORA Sector Group. Eighty-eight percent of the workplaces inspected were cited for violations of at least one MIOSHA safety rule. In 20 of the 26 (76.9%) companies inspected, the hazard that caused the crushing injury had not been corrected at the time of the inspection, which was conducted two to six months after the crushing injury occurred.

**Table 8. Workplaces Inspected by MIOSHA: Violations and Penalties Assessed by NORA Sector Groups, Michigan 2021–2022**

NORA Sector Group	Enforcement Inspections	Companies Cited	Violations	Violations Injury Related	Recom-mendations	Total Penalties Assessed
Manufacturing	18	15	48	42	2	\$ 82,700
Wholesale & Retail	4	4	9	4	0	\$ 12,000
Trade						
Services (except Public Safety)	2	2	4	4	0	\$ 5,900
Construction	1	1	3	3	0	\$ 400
Transportation, Warehousing & Utilities	1	1	1	1	0	\$ 4,800
<b>Total</b>	<b>26</b>	<b>23</b>	<b>65</b>	<b>54</b>	<b>2</b>	<b>\$105,800</b>

## **Examples of Work-Related Crushing Injury MIOSHA Enforcement Inspections**

### **➤ *Concrete Product Manufacturer***

A male in his early twenties sustained a crushing injury when a 1,000-pound cement concrete pallet broke from a crane and landed on his foot and ankle. This resulted in a fracture to his foot. MIOSHA found seven serious violations: “Improper training and no permit was provided prior to lifting and rotating over 1,000 pounds of concrete with an overhead crane in the shop area; An inspection was not performed at the beginning of each shift prior to lifting and rotating over 1,000 pounds of concrete with an overhead crane in the shop area; The sling was not securely attached to the load and employee was not kept clear of a suspended load while lifting and rotating over 1,000 pounds of concrete with an overhead crane in the shop area; There were no identification markings on the Chain Slings used to lift and rotate over 1,000 pounds of concrete with an overhead crane in the shop area; There were no inspections performed on the Chain Slings used to lift and rotate over 1,000 pounds of concrete with an overhead crane in the shop area; Worn or damaged Chain Slings were used to lift and rotate over 1,000 pounds of concrete with an overhead crane in the shop area; There were no identification markings on the Spreader Beam Attachment used to lift and rotate over 1,000 pounds of concrete with an overhead crane in the shop area.” The company had not corrected the hazard at the time of the conduction of the inspection, 4 months later.

### **➤ *Plastics Product Manufacturer***

A male in his mid-forties sustained a crushing injury when his hand was caught by a robot. This caused a fracture, laceration, and degloving, and resulted in hospitalization. MIOSHA found two serious, one other-than-serious, and one “repeat-other” violation: “Lockout procedures were not utilized for servicing tasks on a robotic cell; The employer’s lockout training did not effectively communicate to affected employees, the conditions requiring the use of energy control procedures; The employer did not electronically submit the information from their 2021 MIOSHA Form 300A to the Injury Tracking Application database; The employer did not report an inpatient hospitalization to MIOSHA within 24 hours.”

➤ *Paper Mill*

A male in his late twenties sustained a crushing injury when his hand was crushed and lacerated in a machine resulting in hospitalization. MIOSHA found one serious and three other-than serious violations: “Employees “turn up” on the paper machine by reaching over guards to break the paper using a compressed air wand exposing themselves to the nip pinch point between the finished roll and the drum roller; There were air wands pressured above 30 pounds per square inch at the paper machine with no dead-end relief; The employer did not distinguish between days away from work and days with restricted work for an injury; The employer did not electronically submit the information from their 2021 MIOSHA Form 300A to the Injury Tracking Application database.” The company had not corrected the hazard at the time of the conduction of the inspection, 4 months later.

➤ *Commercial and Industrial Refrigeration Equipment Manufacturer*

A male in his early sixties sustained a crushing injury when both of his hands got caught in a press. This resulted in fractures and lacerations to fingers of both of his hands. MIOSHA found one serious and one other-than-serious violation: “There was inadequate training provided to a new employee on the operating procedures, hazards, and safeguards for the press; The employer did not electronically submit the information from their 2021 MIOSHA Form 300A to the Injury Tracking Application database.”

➤ *Precision Machine and Manufacturer*

A male in his early forties was working as a machinist when he sustained a crushing injury after his hair became caught in a drill press and slammed his head against a metal cabinet. This resulted in a hospitalization due to blunt head trauma with brain hemorrhaging and a near degloving scalp injury. MIOSHA found two serious violations: “There was no written certification that a personal protective equipment hazard assessment had been performed by job task or area within the facility; A hat, cap, or net to hold long hair in place was not worn by an employee while operating a milling machine in the shop area.”

➤ *Nursery and Floriculture Producer*

A male in his early twenties was run over by a bobcat operated by a co-worker who was excavating a tree. The employee was hospitalized due to this crushing injury. MIOSHA found one serious and three other-than serious violations: “Among other methods, one feasible and acceptable abatement method to correct this hazard is to prohibit employees from walking/working within the hazardous area of the equipment; The employer did not post the annual summary of year 2022; The employer did not report within 24 hours to MIOSHA the inpatient hospitalization of an employee; The employer did not electronically submit the information from their 2022 MIOSHA Form 300A to the Injury Tracking Application database.” The company had not corrected the hazard at the time of the conduction of the inspection, 5 months later.

➤ *General Warehousing and Storage*

A male in his mid-thirties suffered a crushing injury when he was compressed between a stack of pallets and pallets on a forklift. MIOSHA found one serious violation: “A powered industrial truck operator lost track of the location of a pedestrian helper and struck the pedestrian with a load of stock resulting in a lost time injury.”

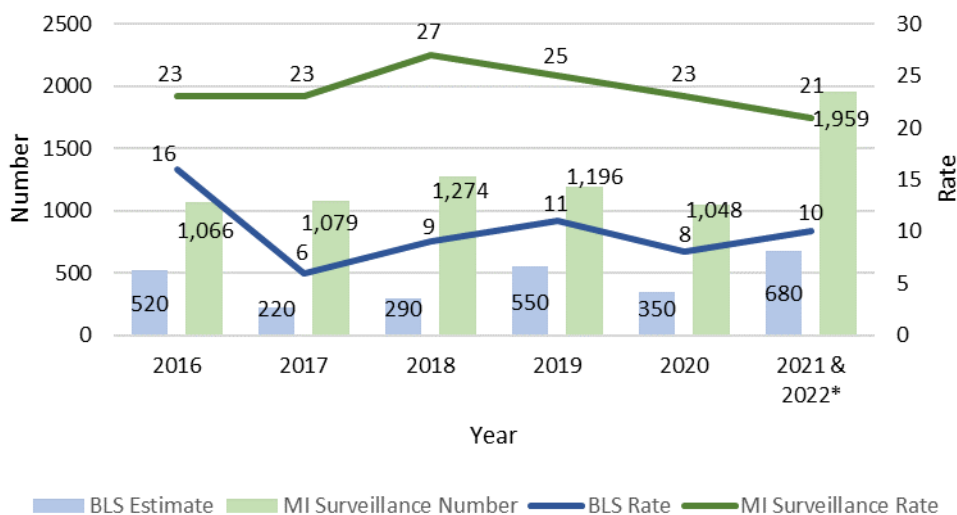
➤ *Screen Printer and Embroiderer*

A male in his late thirties was crushed between two metal plates of a hydraulic press resulting in fractured ribs and hospitalization. MIOSHA found one serious and one other-than-serious violation: Required elements of an energy control program were not developed, implemented, or maintained; The employer did not report within 24 hours to MIOSHA the inpatient hospitalization of an employee.” The company had not corrected the hazard at the time of the conduction of the inspection, 5 months later.

## DISCUSSION

This is the fourth report on work-related crushing injuries in Michigan. It covers two calendar years, 2021 and 2022. The Michigan surveillance system for work-related crushing injuries provides a more accurate estimate of the true number of work-related crushing injuries than the employer-based reporting system maintained by the U.S. BLS, which is the source of official statistics. For years 2021 and 2022, the Michigan system identified 1,959 work-related crushing injuries in comparison to 680 estimated by BLS (Figure 5). We are encouraged by the decline in the number and rate of crushing injuries in 2021 and 2022, which continues a trend from 2018. We will continue to monitor this trend in future years. In 2021, BLS began releasing biennial reports of injuries and illnesses, so the data are combined for 2021 and 2022. The employer-based system identified a much smaller estimate than the Michigan system. BLS' rates of crushing injuries per 100,000 full-time equivalents are smaller (10 between 2021 and 2022) in comparison to the rates of crushing injuries per 100,000 workers identified in the Michigan multi-source surveillance system (21 between 2021 and 2022).

**Figure 5. Number and Rate (per 100,000 workers) of Work-Related Crushing Injuries Comparing BLS and MI Surveillance<sup>a</sup>, Michigan 2016–2022**



<sup>a</sup>BLS rate is calculated per 100,000 full-time equivalent workers and MI Surveillance rate is calculated per 100,000 workers.

\*BLS began reporting injury and illness data biennially in 2021

For 2021 and 2022 BLS estimated only 34.7% of the 1,959 work-related crushing injuries reported in the Michigan's multi-source reporting system. This is a similar estimate to 2016 through 2020, for which BLS estimated 34.1% of the 5,663 crushing injuries



reported in Michigan's multi-source reporting system. The BLS estimate in this report is similar to the estimate in 2013 through 2015, for which BLS estimated 40% of the 3,137 crushing injuries reported in Michigan's multi-source reporting system. The criteria to obtain the estimate were the same for all years.

The BLS undercount of work-related crushing injuries is partially explained by the fact that BLS only knows the type of injury for cases with one or more days away from work or with altered work duties, whereas the Michigan multi-source surveillance system counted all reported work-related crushing injuries. The BLS excludes self-employed, household employees and farm workers who work on farms with less than 11 employees. Michigan's crushing injuries surveillance identified only 54 self-employed individuals between 2021 and 2022, and 54 workers in the Agriculture, Forestry & Fishing NORA Sector Group during the two years of surveillance with work-related crushing injuries so the difference in the type of workers covered in the BLS survey was not an important factor to explain the undercount in the BLS data. Other possible explanations for the BLS undercount may be that employers are not providing complete reporting, or the statistical sampling procedure of BLS, or employers are not properly identifying employees' injuries as crushing injuries. A factor that will cause differences in the rates between the Michigan multi-source system and BLS is that the denominator used in the Michigan multi-source system is the number of workers and BLS uses full-time equivalents.

Workers' Compensation was identified as the payer for only 68.2% of the 1,437 work-related crushing injuries treated at Michigan hospital and emergency department where source of payment was known. Another 50 (3.5%) were not covered by workers' compensation (i.e., self-employed). Workers' compensation should have paid for 96.5% of the work-related crushing injuries after excluding the self-employed. We do not know the reasons why workers' compensation was not the recorded payer for the other 28.3% of the hospitalizations/ED visits.

The Workers' Compensation database had record of 142 crushing injuries that were identified by hospital/ED records and two crushing injuries that were identified by MIFACE (as indicated by the purple circle in Figure 1). An additional 200 crushing injuries identified by hospital/ED records were also in the WDCA but classified as something other than a "Crush/Contusion" injury and two crushing injuries identified by MIFACE were in WDCA

but classified as something other than a “Crush/Contusion” injury. In total, WDCA had record of only 346 (17.7%) of the 1,959 work-related crushing injuries that were identified by Michigan’s surveillance system. The possible explanations for the Workers’ Compensation difference include: 1) The WDCA data set only included crushing injuries that caused seven or more consecutive days away from work, presumably the most severe cases; 2) WDCA excluded the self-employed, but again there were only 54 self-employed workers between 2021 and 2022 in Michigan’ multi-source reporting system; 3) Coding or miscoding errors in the WDCA data. The matching with hospital records showed that 196 work-related crushing injuries identified from medical records were not classified as crushing injuries 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) Workers’ Compensation Condition Type Code combined crush and contusion injuries into one code with no possibility to differentiate those two injury types; 5) It is possible that some companies are handling crushing injuries unofficially and not reporting them to Workers’ Compensation insurance companies or the WDCA.

Surveillance of work-related crushing injuries is crucial to the recognition and prevention of these conditions. A large advantage of the Michigan surveillance system is that it not only provides a better count of the total number of work-related crushing injuries, but the reports can also be used to identify specific workplaces to perform follow back investigations. Between 2021 and 2022, 26 worksites were identified by the surveillance data with a subsequent investigation by MIOSHA to reduce the hazard of a future work-related crushing injury or other serious injury to other employees. Eighty-eight percent (23) of the inspected companies were cited, and despite a serious injury at those workplaces, 76.9% (20) of the inspected companies had not corrected the hazardous situation months after the injury.

We have developed educational materials for distribution to employers and employees where we see patterns in causes for work-related injuries (<https://oem.msu.edu/index.php/work-related-injuries/miface-hazard-alerts>).<sup>10</sup> A hazard alert on crushing injuries from presses has been developed ([https://oem.msu.edu/images/Alerts/2020/Press\\_Crush.pdf](https://oem.msu.edu/images/Alerts/2020/Press_Crush.pdf)).<sup>11</sup> Development and distribution of this information allows employers to work with employees to implement

effective prevention strategies for injuries at more facilities than where a MIOSHA inspection was performed.

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