

# Work-Related Amputations Michigan 2018-2020

December 2022



# **Work-Related Amputations in Michigan: Twelfth Report (January 2018 – December 2020)**

**Michigan State University**

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# Executive Summary

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The Division of Occupational and Environmental Medicine (OEM) at Michigan State University (MSU) and the Michigan Department of Health and Human Services (MDHHS) monitor work-related amputations in Michigan. All Michigan hospitals are required to report work-related amputations and serve as the primary case-finding source. The MSU OEM Division also uses data from the Michigan Workers' Disability Compensation Agency (WDCA) to identify additional amputations. Amputations reported by hospitals were reviewed to identify amputations for which an inspection by the Michigan Occupational Safety and Health Administration (MIOSHA) might be useful to prevent additional amputations. Surveillance data were also used to describe trends and identify workers and industries with high risk of having a work-related amputation. This report describes work-related amputations that occurred in Michigan from 2018-2020 and results of MIOSHA follow-up of selected amputations.

## Key results include:

- Hospitals were the primary data source for 83.5% of work-related amputations. The remaining 16.5% of amputations were found only through the WDCA.
- A total of 1,321 work-related amputations occurred in Michigan between 2018-2020. Based on reports from employers during this same time, the Bureau of Labor Statistics (BLS) estimated there were only 690 work-related amputations in Michigan.
- There were 490 work-related amputations in Michigan in 2018 (11.0 per 100,000 employed persons), 461 in 2019 (10.4 per 100,000 employed persons), and 370 in 2020 (9.0 per 100,000 employed persons)
- The amputation rate was over six times higher among male workers than female workers.
- 38.6 % of amputations occurred in the manufacturing sector. Within manufacturing, wood products manufacturing had the highest rate of work-related amputations. (148.3 amputations per 100,000 employed persons)
- The leading cause of work-related amputations was pinching between objects, causing 17.1% of amputations.
- 92.7% of amputations involved fingers. 10.5% of finger amputations involved multiple fingers.
- The expected payer for medical treatment was workers' compensation for 73.6% of the amputations.
- From 2006 to 2020, the number of work-related amputations fell by 50.5% and the rate fell by 48.9%.
- The Michigan Occupational Safety and Health Administration (MIOSHA) inspected 38 of the worksites identified by a hospital report of an amputation; 34 received citations for a hazard directly related to the amputations and MIOSHA assessed an average of 2.2 violations and \$6,290 in penalties per worksite. None of the hazards that caused the amputations were corrected prior to the MIOSHA inspection, which occurred three to six months after the amputation.

This system, which combines data from medical records and workers' compensation claims provides a more accurate estimate of the number of work-related amputations in Michigan than the official estimate provided by BLS. The Michigan surveillance system identified almost twice as many (1,321 vs. 690) work-related amputations as the BLS employer Survey of Occupational Injuries and Illnesses (SOII).

# Background

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This report represents the 12th annual report of work-related amputations in Michigan from the MSU OEM Division. Amputations are one of the most debilitating injuries that can occur. In many cases, medical and surgical treatment cannot prevent the loss of function of the affected body part. Following an amputation, workers may have to make significant physical and psychological adjustments in the workplace and their personal lives.

The United States Department of Labor, Bureau of Labor Statistics estimated that in 2018, 2019, and 2020, there were 6,200, 6,020, and 4,760 amputations involving days away from work in the U.S. The 21% decrease in amputations in 2020 was most likely due to stay-at-home work orders due to the COVID-19 pandemic. Workers lost an average median of 27 workdays for amputations compared to the average nine for all work-related injuries between the years of 2018-2020.<sup>1</sup> Reducing work-related amputations is a public health priority. The Council of State and Territorial Epidemiologists (CSTE) and the National Institute for Occupational Safety and Health (NIOSH) have developed a set of 24 occupational health indicators, including two related to work-related amputations, to track progress on the goal of reducing amputations.<sup>2</sup>

The MSU OEM Division began reviewing hospital records for amputations in 2004 and developed a comprehensive system in 2006. The current system includes data from hospital records and the Michigan WDCA, to provide a complete count of work-related amputations. To help employers, MIOSHA works with the occupational safety and health community to identify and address workplace hazards so that employers can take action to improve the safety of their workers. MSU OEM Division works with MIOSHA to ensure that appropriate follow-up occurs for cases identified by the surveillance system that were not previously reported to MIOSHA and where there is evidence that workplace hazards need to be addressed. This report summarizes work-related amputations identified by this surveillance system and the results of MIOSHA worksite follow-up of selected cases, for 2018 through 2020.

## Data Sources

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Work-related amputation cases were identified through medical records submitted by Michigan hospitals to the MSU OEM Division as required by the Michigan Public Health Code.<sup>3</sup> MSU acts as MDHHS's bona fide agent to oversee this requirement. Medical records are sent directly to the OEM Division of MSU.

The Michigan WDCA provided access to wage replacement claims data under a confidentiality agreement. A worker must miss seven or more consecutive days of work or experience "specific losses" to qualify for wage replacement. For this report, a specific loss indicates amputations of at least an entire phalanx (the bone of a finger or toe).

MIOSHA inspection reports provide information on the number of violations and total penalties for worksites that were inspected based on hospital reports. Workers' compensation data was not used to identify companies for inspection. The number of workers employed in Michigan by age, sex, and industry was estimated using the Quarterly Workforce Indicators (QWI) from the U.S. Census.<sup>4</sup> The QWI utilizes data from the Longitudinal Employer-Household Dynamics (LEHD) linked employer-employee microdata. BLS Local Area Unemployment Statistics (LAUS) provided the number of employed Michigan residents in each county.<sup>5</sup>

# Methods

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Cases identified by hospital medical records were included if they

- Received medical treatment at a Michigan hospital, emergency department, or outpatient setting.
- Had at least one of the following International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)<sup>6</sup> diagnosis codes assigned at any level of diagnostic priority in the medical record: S48, S58, S68, S78, S88, or S98.
- Sustained the amputation at work in 2018, 2019, or 2020.

Cases identified from WDCA claims were included if they:

- Had an accepted wage replacement claim related to a work-related amputation occurring in 2018, 2019 or 2020.

Cases were reviewed and cleaned for discrepancies in the data. All duplicates were removed from the data set. Cases with an amputation of a body part besides an upper or lower extremity amputation (for example, the eye) were not included.

Information abstracted from medical records included the patient's name, hospital name, date of admission, date of discharge, date of birth (DOB), race, ethnicity, social security number (SSN), city and county of residence, primary source of payment, employer name, employer address, injury date, body part amputated, ICD-10-CM code(s), degree of injury, and cause of injury. A North American Industry Classification System (NAICS)<sup>7</sup> code was assigned to each amputation based on employer. MSU staff attempted to interview patients by phone if medical records lacked sufficient information on where the injury occurred, the employer, or other important details.

Once medical record abstraction and patient interviews were complete, records were linked to the workers' compensation claims database to obtain complete information on the case demographic characteristics (e.g., age, sex), employer industry, and the area of the body that was affected by the amputation, if missing from the medical record.

Record linkage between the hospital and WDCA data was performed using SAS 9.4. Records were first compiled into years, with one record based on one-year workers' compensation data and another final record containing hospital amputation data for that year. Records were initially linked using the whole SSN and date of injury. Remainder non-matches were then matched using the last four digits of their SSN and the case's DOB. Definitive cases were removed from the remainder, and the remainder of non-matches were matched using only DOB. After removing amputations with the same DOBs, the two data files were matched on the full name. The remaining non-matched amputations were linked using last name and birth year, after which linkage was performed using the last four digits of the SSN, and again any matches were removed. The final linkage was then performed, matching on date of birth and sex. After each iteration of matching, matches were visually inspected to verify that they were true matches. Once the 2018, 2019, and 2020 matched data set was created those data sets were then concatenated with Workers' compensation paid claims that had cause limited to AMPUTATION. The data sets were then concatenated with the unmatched medical records. The final data sets were checked for duplication. All three datasets were then combined to create one data set for analysis. One more check

was performed to identify cases that sustained an amputation in one year but did not have a workers' compensation claim date until the following year. Any cases with a medical record one year and a subsequent worker comp case the following year was linked to create the final analytical data set.

Rates were calculated by sex, age group, and type of industry by dividing the number of workers that experienced an amputation by the average number of persons employed each year in Michigan from 2018-2020 within each category and multiplying the result by 100,000. Rates by county of residence were calculated by dividing the number of Michigan residents who sustained a work-related amputation by the average number of employed persons in the county each year in Michigan from 2018-2020 and multiplying the result by 100,000. Thus, rates represent the average annual rate for the three-year period. Because of statistical variability with small numbers, rates were not calculated when the relative standard error (RSE) was  $\geq 40\%$ . The RSE was calculated by dividing the standard error of a rate by the rate and multiplying the result by 100.

MIOSHA reviewed cases if the worksite was in Michigan and the amputation was caused by a hazard likely to be found in an inspection (e.g., absence of a guard on a saw) or a mechanical power press was involved (employers are required to report injuries caused by mechanical power presses to MIOSHA). MIOSHA did not review cases when the cause of injury was vaguely described in medical records (e.g., "pinched between objects"). For cases inspected by MIOSHA, the inspection date, number of violations, number of violations related to the identified hazard, whether the hazards had been corrected at the time of the inspection, power press violations, and total fines assessed were compiled by the MSU OEM Division. Data provided by the Michigan WDCA was restricted to surveillance and was not used for enforcement purposes. Therefore, cases found exclusively in workers' compensation records were not reviewed by MIOSHA. Database management was conducted using Microsoft Access. Data analysis was performed using Microsoft Excel and SAS 9.4.

## Results

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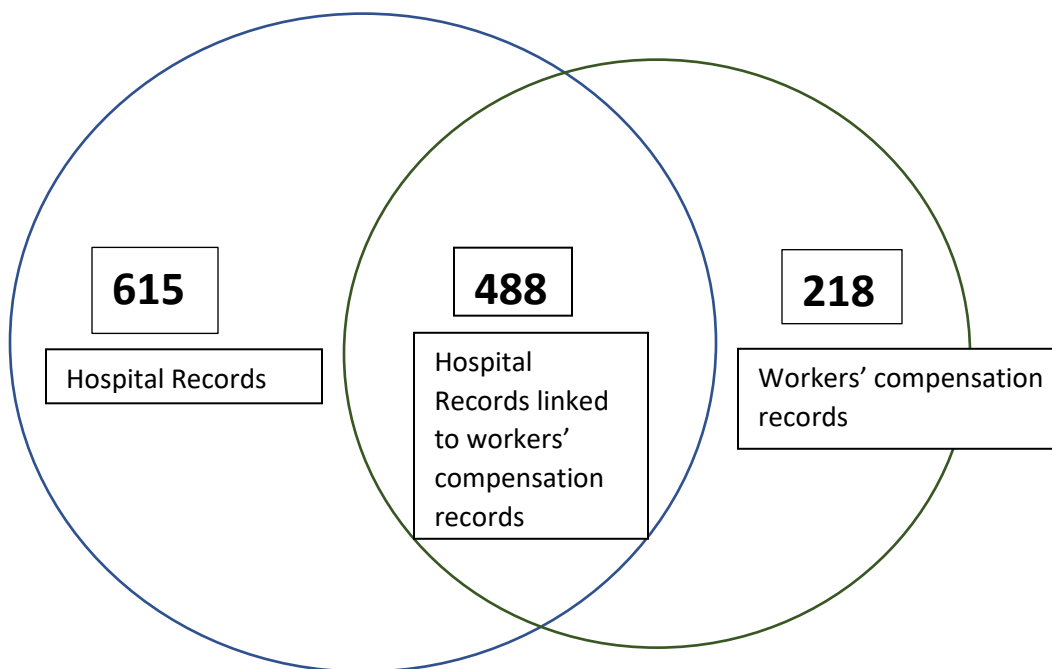
All 134 acute care hospitals, including the four Veteran's Administration (VA) medical centers in Michigan complied with the reporting requirement. For 2018, 86 hospitals, for 2019, 87 hospitals and for 2020, 91 hospitals submitted medical records for potential work-related amputations. For all three years, the other hospitals that did not submit any potential work-related amputations reported that they had no work-related amputations for that year.

Table 1 and Figure 1 display the results of the matching process and from which source the amputations were ascertained. The workers' compensation database contained a total of 446 amputations that were either paid, partially paid, or expected to be paid: 161 for 2018, 168 for 2019 and 117 for 2020. 218 of the 1,321 (16.5%) amputations were only identified in the workers' compensation data base. Two hundred and sixty of the 488 (53.3%) amputations identified in both the workers' compensation data base and the hospital medical records were listed as non-amputation injuries in the workers' compensation data base, although they were considered an amputation in the hospital medical records.

**TABLE 1 Results of Matching Work-Related Amputations Ascertained from Hospital Medical Records and Workers' Compensation Paid Claims, Michigan, 2018-2020**

Paid Injury Claim in Workers' Compensation Database	Amputation in Hospital Medical Records		
	Yes	No	Total
Yes - amputation injury	228	218	<b>446</b>
Yes -non-amputation injury	260	-	<b>260</b>
No	615	0	<b>615</b>
<b>Total</b>	<b>1,103</b>	<b>218</b>	<b>1,321</b>

**Figure 1: Reporting Sources of Work-related Amputations, Michigan 2018-2020**



## Characteristics of Injured Workers for 2018-2020

### Age and Sex

Sex was not available for eight workers. There were 1,155 (88%) men and 158 women (12%) who had a work-related amputation. The incidence rate for men was highest in those aged 19-21 years (26.1/100,000) and for women in those aged 19-21 and 22-24 (4.0/100,000) (Figure 2). For a further breakdown of amputations by age and sex see Table A-1 in Appendix A.



**Figure 2. Average Annual Work-Related Amputation Injury Rates per 100,000 by Age Group and Sex, Michigan 2018-2020**



## Race and Hispanic Ethnicity

Medical records were missing information on race for 767 patients (58.1%) and on ethnicity for 1018 patients (77.1%). Workers' compensation claims do not collect data on race and ethnicity. Among the 554 of the amputations with race data, 455 (82.1%) were white, 69 (12.5%) were African American, 5 (0.9%) were Asian, and 25 (4.5%) were "Other". Among the 303 amputations with data on Hispanic ethnicity 33 individuals (9.9%) were of Hispanic origin and 270 individuals (80.1%) were not of Hispanic origin. For a further breakdown of amputations by race and ethnicity see Table A-2 in Appendix A. Due to the level of missing information, rates for racial/ethnic groups were not calculated

### **Case Study One:**

A man in his 50's reached into the debris chute of a lawn mower to remove grass clippings and had near complete amputation of his right second and third digits at the midportion of the middle phalanx with extensive soft issue injury and foreign debris. MIOSHA Inspected the facility, and the company was given two citations; One for not turning off the lawn mower when clearing clogs or jams and the other for failure to report the amputation to MIOSHA within 24 hours after the injury occurred. The penalty total was \$3,600.

## Body Part and Severity

Most amputations (92.7%) involved at least one finger (Table 2). Medical records provide more detail on the extent of amputation than workers' compensation claims. Of the 1,224 finger amputation incidents, 128 (10.5%) involved multiple fingers. Table 3 displays the distribution of digit(s) and section(s) lost among all finger amputations. The distal phalanx was most amputated section (71.3%) of finger amputations. If multiple body parts were listed in a case amputation and did not fit into one category, they were listed as other.

**TABLE 2: Number and Percent of Work-Related Amputations Occurring in Michigan by Injured Body Part, 2018-2020**

Body part	Number	Percent
Finger	1,224	92.7
Hand	25	1.9
Arm	7	0.5
Unspecified upper extremity	1	0.1
Toe	18	1.4
Foot	27	2.0
Leg	12	0.9
Unspecified lower extremity	3	0.2
Multiple parts	4	0.3
Total	1,321	100

*Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA*

### **Case Study Two:**

A man in his 30s had his left hand stuck in a conveyor belt while at work. To free his hand, he had a coworker run the machine in reverse so he could remove his hand from the conveyor belt. The man suffered multiple lacerations to his hand, including a near-complete amputation of his fifth digit at the distal interphalangeal joint. MIOSHA Inspected the facility, and the company was given three citations. One for not lockouting the equipment when aligning the sprocket with the power on the 2-Strand plastic belt conveyor and failure to write up lockout procedures. The second violation other two violations was failure to train the employee about lockout procedures. The third was a failure to report the amputation to MIOSHA within 24 hours after the injury occurred. The penalty total was \$7,200.

**TABLE 3: Number and Percent of Work-Related Finger Amputations Occurring in Michigan by Digit and Section of Finger Lost, 2018-2020 †**

Digit	Section	Number	Percent
Little	Distal	80	7.9
Little	Middle	15	1.5
Little	Proximal	8	0.8
Little	Unknown	8	0.8
Ring	Distal	99	9.8
Ring	Middle	9	0.9
Ring	Proximal	6	0.6
Ring	Unknown	10	1.0
Middle	Distal	182	17.9
Middle	Middle	10	1.0
Middle	Proximal	5	0.5
Middle	Unknown	13	1.3
Index	Distal	237	23.3
Index	Middle	31	3.1
Index	Proximal	14	1.4
Index	Unknown	13	1.3
Thumb	Distal	126	12.4
Thumb	Proximal	23	2.3
Thumb	Unknown	9	0.9
Unknown	Distal	82	8.1
Unknown	Middle	15	1.5
Unknown	Proximal	20	2.0
Total	All	1,015*	100

† Includes sections lost in single- and multiple-finger loss incidents. Workers' compensation claims do not contain data on section of finger lost and thus are excluded from the table.

\* Does not include the 97 non-finger amputations and the 209 finger injuries with unknown fingers and location of amputation (195 of the 209 are solely from workers' compensation data which does not include information on which finger was amputated).

Data Source: Michigan hospital medical records

## County of Residency

Table 4 displays the number of work-related amputations and average annual rate per 100,000 workers by county of residence for work-related that occurred in Michigan. These data do not necessarily reflect the counties with the highest risk worksites because workers may be employed outside their county of residence. Six counties had no residents with work-related amputations. In counties with enough amputations to calculate statistically reliable rates Roscommon had the highest rate (33.0 per 100,000 workers). Among the 20 most populous counties in the state (highlighted below), Calhoun County had the highest rate (17.1 per 100,000) while Oakland County had the lowest (4.4 per 100,000).

**TABLE 4: Number and Average Annual Rate (per 100,000) of Work-Related Amputations Occurring in Michigan by County of Residence, 2018-2020\***

County	Number	Rate	County	Number	Rate
ALCONA	0	0	LAPEER	24	20.9
ALGER	0	0	LEELANAU	2	*
ALLEGAN	24	13.5	LENAWEE	13	9.9
ALPENA	5	*	LIVINGSTON	17	5.7
ANTRIM	2	*	LUCE	0	0
ARENAC	3	*	MACKINAC	1	*
BARAGA	3	*	MACOMB	132	10.5
BARRY	7	7.7	MANISTEE	3	*
BAY	14	10.0	MARQUETTE	3	*
BENZIE	3	*	MASON	8	21.0
BERRIEN	19	9.2	MECOSTA	7	13.5
BRANCH	16	29	MENOMINEE	3	*
CALHOUN	30	17.1	MIDLAND	7	6.1
CASS	6	8.7	MISSAUKEE	4	*
CHARLEVOIX	6	16.7	MONROE	13	6.1
CHEBOYGAN	5	*	MONTCALM	10	12.6
CHIPPEWA	0	0	MONTMORENCY	4	*
CLARE	7	21.6	MUSKEGON	30	13.8
CLINTON	19	16.2	NEWAYGO	7	10.6
CRAWFORD	1	*	OAKLAND	85	4.4
DELTA	0	0	OCEANA	6	18.0
DICKINSON	9	25.7	OGEMAW	2	*
EATON	16	9.9	ONTONAGON	0	0
EMMET	10	20.5	OSCEOLA	4	*
GENESEE	44	8.8	OSCODA	2	*
GLADWIN	4	*	OTSEGO	2	*
GOGEBIC	2	*	OTTAWA	29	6.3
GRAND TRAVERSE	19	13.6	PRESQUE ISLE	5	*
GRATIOT	10	19.8	ROSCOMMON	7	33.0
HILLSDALE	8	13.9	SAGINAW	24	9.9
HOUGHTON	3	*	ST CLAIR	27	12.7
HURON	5	*	ST JOSEPH	10	12.4
INGHAM	28	6.6	SANILAC	8	14.7
IONIA	11	12.8	SCHOOLCRAFT	1	*
IOSCO	3	*	SHIAWASSEE	13	13.9
IRON	5	*	TUSCOLA	9	13.6
ISABELLA	9	9.3	VAN BUREN	17	17.2
JACKSON	30	14.2	WASHTENAW	30	5.3
KALAMAZOO	29	7.6	WAYNE	187	8.4
KALKASKA	2	*	WEXFORD	3	*
KENT	77	7.5	UNKNOWN	35	N/A
KEWEENAW	1	*	Out of state	30	N/A
LAKE	2	*	TOTAL	1321	9.5

Counties which are highlighted make up the top 20 populated counties in Michigan

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

Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA

## Causes of Amputations

Table 5 displays the number and percent of work-related amputations by cause. Being pinched between objects was the most common cause of an amputation cases (17.1%) followed by power saws (e.g., table saws, miter saws) (15.6%). An amputation was labeled as pinched between objects when the digit was caught between two objects. These injuries usually consist of a finger being pinched and amputated by a door or two pieces of metal. Presses caused 8.8 % of work-related amputations. Other types of machinery, many of which were specified but grouped together due to the variety of machinery, caused 15.5% of amputations. The cause of the amputation was unknown for 273 cases (20.7%), including all cases identified only through workers' compensation claims.

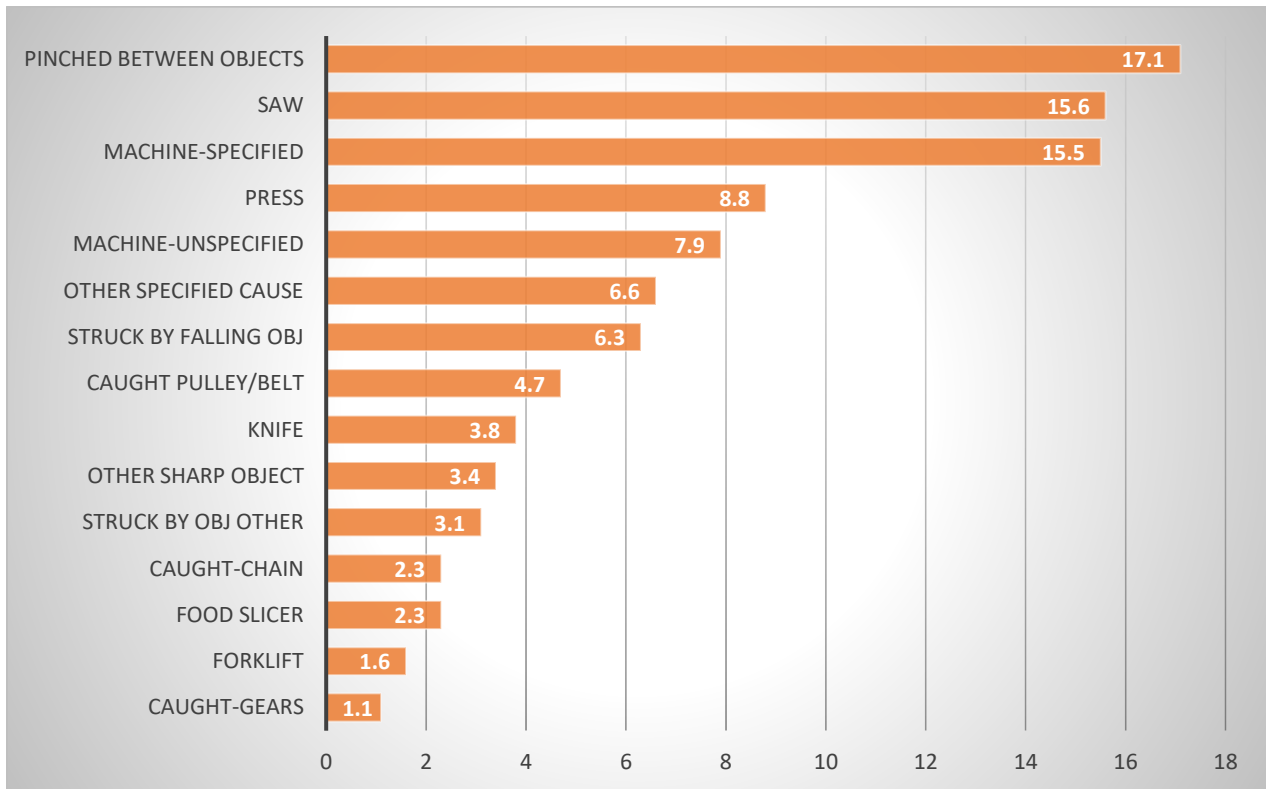
**TABLE 5: Number and Percent of Work-Related Amputations Occurring in Michigan by Cause of Injury, 2018-2020**

Cause of Injury	Number	Percent
Pinched between objects	179	17.1
Saw	163	15.6
Machine- specified	162	15.5
Press	92	8.8
Machine- unspecified	83	7.9
Other specified cause	69	6.6
Struck by falling object	66	6.3
Caught Pulley/belt	49	4.7
Knife	40	3.8
Other Sharp object	36	3.4
Struck by obj other	32	3.1
Food slicer	24	2.3
Caught-Chain	24	2.3
Forklift	17	1.6
Caught-Gears	12	1.1
Total	1,048*	100

*\*Cause of injury was unknown for 273 amputations*

*Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA*

**FIGURE 3: Percent of Work-Related Amputations Occurring in Michigan by Cause of Injury, 2018-2020\***



\*Cause of amputation Injuries was provided for 1,048 (79.3%) cases. Figure does not include unknown cases (273) including the 218 amputations only identified in the workers' compensation data, which does not include cause of injury.

## INDUSTRY

Table 6 shows the number and average annual rate of work-related amputations by industry. There were 217 cases without enough detail to make an industry classification. Among the main industry sectors, the Agriculture, Forestry, Fishing, and Hunting industry had the highest rate of amputations (79.8 per 100,000 workers) and the Crop and Animal Production subsector accounted for 83.8 % of amputations in this sector. The greatest proportion (38.6%) of amputations occurred in the Manufacturing Industry. The Wood Products Manufacturing subsector had a considerably higher rate (148.3 per 100,000) than any other subsector.

**TABLE 6: Number and Average Annual Rate (per 100,000) of Work-Related Amputations Occurring in Michigan by Industry, 2018-2020**

NAICS Code	Industry Classification	Number	Rate
11	<b>Agriculture, forestry, fishing, and hunting</b>	68	79.8
111-112	Crop and animal production	57	81.4
21	<b>Mining, quarrying, and oil and gas extraction</b>	3	*
22	<b>Utilities</b>	4	*
23	<b>Construction</b>	119	23.0
31-33	<b>Manufacturing</b>	510	27.9
311	Food manufacturing	24	20.8
321	Wood products manufacturing	45	148.3
326	Plastics and rubber products manufacturing	32	27.3
331	Primary metal manufacturing	50	79.6
332	Fabricated metal product manufacturing	99	42.2
333	Machinery manufacturing	65	29.8
336	Transportation equipment manufacturing	100	18.3
42	<b>Wholesale trade</b>	56	11.1
44-45	<b>Retail trade</b>	59	4.4
48-49	<b>Transportation and warehousing</b>	41	10.3
51	<b>Information</b>	3	*
52	<b>Finance and insurance</b>	5	*
53	<b>Real estate and rental and leasing</b>	8	4.9
54	<b>Professional, scientific, and technical services</b>	17	1.9
55	<b>Management of companies and enterprises</b>	0	0
56	<b>Administrative and support and waste management and remediation services</b>	70	8.5
61	<b>Educational services</b>	14	7.2
62	<b>Health care and social assistance</b>	15	0.8
71	<b>Arts, entertainment, and recreation</b>	13	8.7
72	<b>Accommodation and food services</b>	45	4.2
722	Restaurants, food service and drinking places	42	4.4
81	<b>Other services (except public administration)</b>	37	9.2
92	<b>Public administration</b>	17	3.9**
99	<b>Unknown</b>	217	N/A
<b>NA</b>	<b>Total</b>	<b>1,321</b>	<b>9.7</b>

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

\*\* Public administration rates were calculated using United States Census Bureau 1-year public estimate due Quarterly Workforce Indicators (QWI) missing data on public administration

## Source of Payment

As shown in Table 7, workers' compensation was the expected payer in 73.6% of the 1,103 cases with a medical record. Payment source could not be determined for 75 cases with medical records. Among the 383 cases which did not have workers' compensation listed as a payment source in medical records, 92 were linked to a claim in the workers' compensation data.

**TABLE 7: Number and Percent of Work-Related Amputations Occurring in Michigan by Payment Source, 2018-2020**

Type of Payment	Number	Percent
Workers' Compensation	812*	73.6
Commercial insurance	110	10.0
Self	42	3.8
Other	3	0.3
Medicaid/Medicare	61	5.5
Not specified	75	6.8
Total	1,103**	

\*Includes thirteen individuals that were described as self-employed in their medical record

\*\* Excludes 218 amputations, where source of payment was unknown

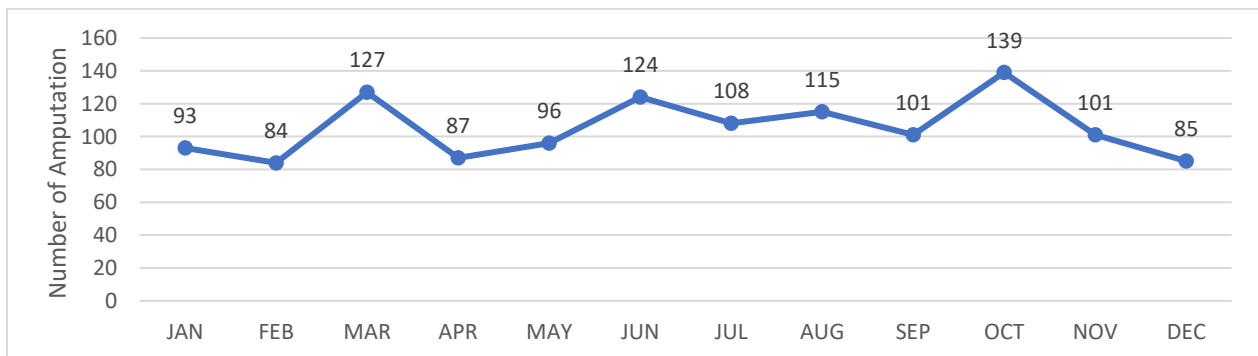
Data Source: Michigan hospital medical records

## Trends

### Amputations by Month

**FIGURE 4: Number of Work-Related Amputations Occurring in Michigan by Month, 2018-2020\***

Work-related amputations occurred most frequently during March and October and were least frequent during February and December (Figure 4). There did not appear to be any seasonality to amputation events.



\*Excludes 61 work-related amputations cases with an unknown date of injury

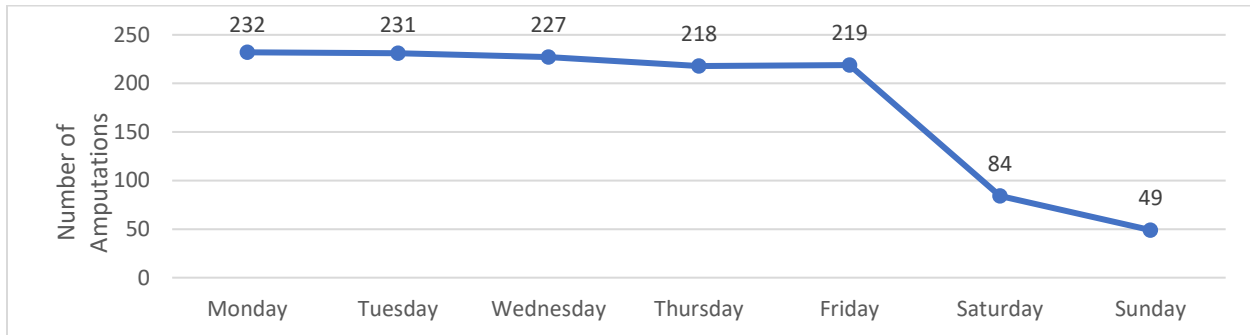
Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA



## Amputations by Day

Work-related amputations were slightly more common at the beginning of the work week and much less common on the weekends (Figure 5).

**FIGURE 5: Number of Work-Related Amputations Occurring in Michigan by Weekday, 2018-2020\***



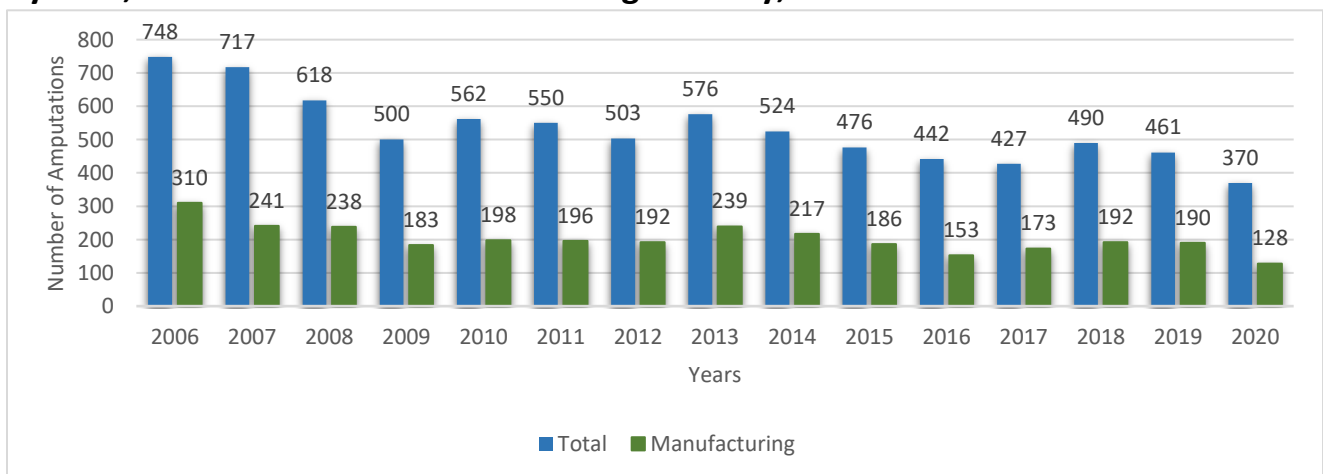
\*Excludes 61 work-related amputations cases with an unknown date of injury

Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA

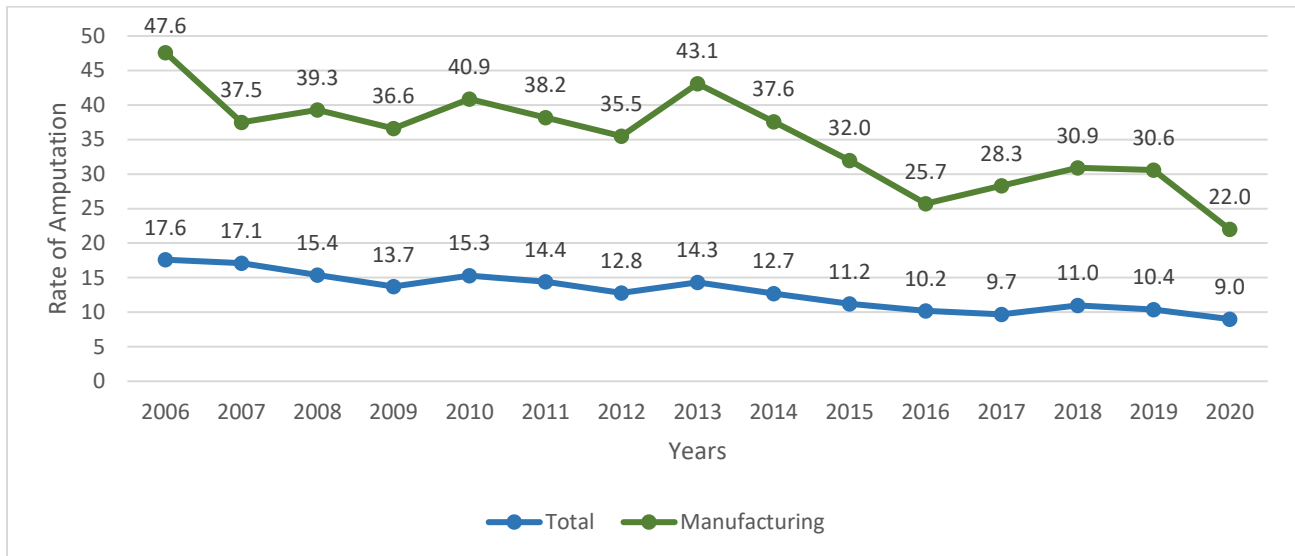
## Amputations by Year

The annual number of amputations decreased by 50.5% during the 15 years the surveillance system has been in place, from 748 in 2006 to 370 in 2020 (Figure 6). In 2020, the relatively low number of amputations presumably was a reflection of stay-at-home orders because of COVID-19. Ignoring the 2020 data, there was still an overall decrease of 38.4% in amputations from 2006 to 2019. The rate of amputations also fell from 17.6 per 100,000 employed persons in 2006 to 10.4 per 100,000 employed persons in 2019, representing a 40.9% decline (Figure 7). Figures 6 and 7 also display the annual number of cases and rates for manufacturing, the industry sector with the most amputations each year. The rate of manufacturing amputations has also markedly declined since 2006.

**FIGURE 6: Annual Number of Work-Related Amputations Occurring in Michigan by Year, Total and for the Manufacturing Industry, 2006-2020**



**FIGURE 7: Annual Rate of Work-Related Amputations Occurring in Michigan by Year, Total and for the Manufacturing Industry, 2006-2020**



**Case Study Three:**

A male in his late teens had his thumb amputated when he attempted to push meat back into a meat grinder. MIOSHA inspected the worksite and found the grinding plate guard had an excessive opening of approximately ¾ inches covering the revolving grinding blades on the meat grinder. The company was issued two violations one for the grinding guard and another for not educating newly assigned employees. The total penalties for both violations were \$3,600.

**MIOSHA Review**

MIOSHA inspected 38 worksites identified from medical records between 2018-2019, but none in 2020, presumably due to COVID-19. The number of violations ranged from one to four. Table 8 shows the distribution of assessed penalties. The maximum penalty was \$16,800 and the median was \$5,600. MIOSHA cited two companies for hydraulic press violations and one company for mechanical press violations. Of the 38 worksites, 34 received citations for a hazard directly related to the amputations. None of these hazards were corrected prior to the inspection even though the inspections occurred three to six months after the amputation had occurred.

**TABLE 8: Violations Identified in MIOSHA Worksite Inspections, 2018-2020**

Number of Violations	Number of Inspections	Percent
1	9	23.7
2	17	44.7
3	8	21.1
4	4	10.5
<b>Total</b>	<b>38</b>	<b>100.0</b>

**TABLE 9: Penalties Assessed in MIOSHA Worksite Inspections, 2018-2020**

Penalty Assessed	Penalty Assessed	Percent
\$1-\$999	1	2.6
\$1,000-\$4,999	19	50.0
\$5,000-\$9,999	12	31.5
\$10,000-\$19,999	6	15.7
<b>Total</b>	<b>38</b>	<b>100.0</b>

## Discussion

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The Michigan work-related amputation surveillance system provides information to identify occupational groups and industries at increased risk for work-related amputations. The surveillance data include demographics of the injured worker and characteristics of the industry. The work-related amputation surveillance system provides important information to MIOSHA that can be used to initiate a workplace inspection. The surveillance system supports MIOSHA’s 2019-2023 Strategic Plan objectives to reduce the rate of worker injuries in high-hazard industries.<sup>8</sup>

The Michigan work-related amputation surveillance system has continued to identify more cases than the BLS SOII. The Michigan work-related amputation surveillance system identified 631 more amputations than BLS SOII from 2018 and 2020. The state-based system has significant advantages over the BLS SOII. The Michigan system can be used to identify individual companies that would benefit from a site visit by MIOSHA. The BLS SOII is an estimate based on a random selection of employers. The BLS SOII is influenced by how closely the employers selected to participate in the survey represent all employers in that industry sector and the accuracy of employer responses. The state-based surveillance system is not subject to sampling bias because it is designed to capture a census of all work-related amputations. The accuracy of injury classification in the Michigan surveillance system is likely better than the BLS SOII due to the availability of medical records for most cases. In contrast, the BLS SOII must rely on the employer’s designation of the injury type.

## Limitations

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Despite the advantages of the Michigan work-related amputation surveillance system over the BLS SOII, several limitations could impact the ability of the state-based surveillance system to identify all cases. First, hospitals may not submit all eligible amputations. In addition, some amputation cases may have been assigned incorrect ICD-10-CM code (e.g., lacerations). Such cases would not have been sent to MSU.

Work-related amputations would be missed if workers received medical treatment exclusively at an out-of-state hospital because hospitals outside Michigan are not required to report amputations to the MSU OEM Division. The state-based surveillance system does not capture cases that do not receive hospital-based medical treatment and do not submit a workers' compensation claim for wage replacement. This limitation most likely affects workers with less severe amputation injuries who only receive medical care in a non-hospital setting, such as an urgent care clinic, and workers who are not eligible for workers' compensation, such as those who work on railroads, are self-employed or are federal employees.

Other limitations are that medical records often do not document the specific cause of the amputation injury. Medical records may also lack information on the patient's employer or industry, and most records did not include information on the patient's race and Hispanic ethnicity. Workers' compensation claims do not collect information on the cause of injury or the worker's race and ethnicity. Workers' compensation claims may lack detailed injury descriptions (e.g., single vs. multiple digit loss, specific digit injured).

## Conclusions

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The Michigan work-related amputation surveillance system leverages hospital reporting and workers' compensation claims data, providing a more accurate number of work-related amputations than the official estimate based on the employer-based reporting system maintained by the BLS. In addition, the hospital reports in the state-based surveillance system are used to target public health interventions to find and reduce workplace amputation hazards. Progress continues to be made in reducing the risk of work-related amputations, evidenced by the decrease in the number and rate of work-related amputations since 2006. The state-based surveillance system provides a vital role in reducing workplace hazards by supporting MIOSHA's inspection activities and by identifying risk factors associated with work-related amputations to target public health interventions

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## Appendix A: Additional Data Tables and Figures

**TABLE A-1: Number and Rate (per 100,000) of Work-Related Amputations that Occurred in Michigan by Age and Sex, 2018-2020\***

Age	Male Count	Male Rate	Female Count	Female Rate	Total Count	Total Rate
14-18	34	23.9	4	**	38	12.3
19-21	73	26.1	12	4.0	85	14.6
22-24	71	20.8	14	4.0	85	12.4
25-34	255	19.4	40	3.4	295	11.8
35-44	230	19.7	23	2.2	253	11.5
45-54	226	19.1	34	3.2	260	11.51
55-64	219	21.2	26	2.8	245	12.6
65+	44	13.9	5	**	49	8.3
TOTAL	1,152	20.0	158	2.9	1,310	11.9

\*3 records did not have enough information to sufficiently categorize age and was removed alongside the 8 workers who did not have a sex assigned.

\*\* Rates are suppressed if the count is between 1 and 5 because such rates are not statistically reliable  
Data Source: Michigan hospital medical records and Michigan Department of LEO WDCA.

**TABLE A-2: Number of Work-Related Amputations among Michigan Residents by Race and Hispanic Ethnicity, 2018-2020**

	Hispanic	Non-Hispanic	Unknown	Total
White	18	216	221	455
Black	0	29	40	69
Asian	0	3	2	5
Other	8	7	10	25
Unknown	7	15	745	767
Total	33	270	1018	1321

\*Data Source: Michigan hospital medical records and Michigan Department of LEO WDCA.