

Work-Related Amputations Michigan 2021-2022

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Work-Related Amputations in Michigan: Twelfth Report (January 2021 – December 2022)

Michigan State University

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Table of Contents

Executive Summary.....	4
Background.....	5
Data Sources.....	5
Methods.....	6
Results.....	7
Age and Sex.....	8
Race and Hispanic Ethnicity.....	9
Body Part and Severity.....	10
County of Residency.....	11
Causes of Amputations.....	12
Industry.....	13
Source of Payment.....	14
Amputations by Month.....	15
Amputations by Day.....	15
Amputations by Year.....	16
MIOSHA Review.....	17
Discussion.....	18
Limitations.....	19
Conclusions.....	19
References.....	20
Appendix A: Additional Data Tables and Figures.....	21

Executive Summary

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 2021–2022 and results of MIOSHA follow-up of selected amputations.

Key results include:

- Hospitals were the primary data source for 79.9% of work-related amputations. The remaining 20.1% of amputations were found only through the WDCA.
- A total of 767 work-related amputations occurred in Michigan between 2021–2022. Based on reports from employers during this same time, the Bureau of Labor Statistics (BLS) estimated there were only 300 work-related amputations in Michigan.
- There were 366 work-related amputations among Michigan residents in 2021 (8.1 per 100,000 workers) and 401 in 2022 (8.4 per 100,000 workers).
- The amputation rate was over seven times as high among male workers than female workers.
- The manufacturing sector had the largest number of amputations (43.2%) of amputations. Within manufacturing, wood products manufacturing had the highest rate of work-related amputations (108.4 amputations per 100,000 workers).
- The leading cause of work-related amputations was from working with a saw, causing 19.9% of amputations.
- Almost all amputations (94.9%) involved fingers while 14.8% of finger amputations involved multiple fingers.
- The expected payer for medical treatment was workers' compensation for 71.4% of the amputations.
- From 2006 to 2022, the number of work-related amputations fell by 46.4% and the rate fell by 51.1%.
- MIOSHA inspected 37 of the 426 worksites identified by a hospital report of an amputation; 30 worksites received citations for a hazard directly related to the amputations. MIOSHA assessed an average of 2.0 violations and \$5,305 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.

The Michigan surveillance 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 U.S. Bureau of Labor Statistics (BLS). The Michigan surveillance system identified over twice as many (767 vs. 300) work-related amputations as the BLS Survey of Occupational Injuries and Illnesses (SOII).

Background

This report represents the 13th report of work-related amputations in Michigan from the Michigan State University Occupational and Environmental Medicine (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 (BLS) estimated that in 2021–2022, there were 10,840 amputations involving days away from work in the United States (U.S.).¹ Workers lost an average of 29 workdays for amputations compared to the average of 10 for all work-related injuries between the years of 2021–2022.¹ 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.²

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 Workers' Disability Compensation Agency (WDCA), to provide a complete count of work-related amputations. To help employers, Michigan Occupational Safety and Health Administration (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 2021 through 2022.

Data Sources

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.³ MSU acts as Michigan Department of Health and Human Services' (MDHHS's) bona fide agent to oversee this requirement. Medical records are sent directly to the MSU OEM Division.

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, county, sex, and industry was estimated using the Quarterly Workforce Indicators (QWI) from the U.S. Census.⁴ The QWI utilizes data from the Longitudinal Employer-Household Dynamics (LEHD) linked employer-employee microdata.⁵

Methods

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)⁶ 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 2021 or 2022.

The Michigan WDCA provided access to a database of predominantly paid claims (97% of amputation claims) for wage replacement due to lost work time with an injury date in 2021 or 2022. Individuals are eligible for wage replacement when they have had at least seven consecutive days away from work. Injuries coded as amputations are included in the WDCA regardless of the number of days away from work.

Cases were reviewed and cleaned for discrepancies in the data. All duplicates were removed from the data set. Only amputations of upper and lower extremities are included in this report. A separate category for amputation that consists of multiple body parts will be listed in a separate category.

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)⁷ code was assigned to each amputation based on employer. MSU staff attempted to interview patients by phone if medical records lacked sufficient information on determining if the injury was an amputation, where the injury occurred, the employer, or what caused the injury. Due to the small number of workers whose residency was considered out of state (<3%), they were included in the final report unless otherwise noted.

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. This was important for obtaining a complete picture of the cause and circumstances surrounding the amputation.

Record linkage between hospital data and all WDCA data, regardless of claim status, was performed using SAS 9.4. Records were first compiled by year, that is, separating the data into injuries that took place in 2021 and 2022. The data were divided based on the year of injury for the WDCA data and, for the hospital data, by year of injury or, when not available, the year of admission. Records were initially linked using the entire Social Security number (SSN) and the date of injury. The remaining non-matches were then matched using the last four digits of the patient's SSN and the patient's date of birth (DOB). Definitive cases were removed from the remainder, and the remaining non-matches would proceed to step two. In step two, the data set was matched using the DOB and the last name of the individual. The records were then manually reviewed and matched if the full name and injury date matched. After removing amputations determined to be full matches the remaining non-matches were then matched in step three based solely on the full name. The purpose of the step three match and the following matches was to identify clerical errors in name, admission date, or DOB that could cause a proper match to be

missed. The remaining non-matched amputations were linked using the last name and birth year. Subsequently, linkage was performed using the last four digits of the Social Security number (SSN), and any accurate matches were removed again. After each iteration of matching, the matches were manually inspected to verify that they were accurate. Once the 2021 and 2022 matched data set was created, the matched data set was then concatenated with then unmatched 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. 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 from one year prior and a subsequent worker's compensation case the following year were linked to create the final analytical data set.

Rates were calculated by sex, race, ethnicity, county of residence, and age group by dividing the number of amputations by the estimated number of persons employed in Michigan multiplied by 100,000. The number of persons employed was obtained from the QWI yearly average of the Beginning of Quarter employment count.⁸ As QWI data were not available for 2022, the 2021 QWI data was multiplied by two to obtain an estimate of the number of persons employed in Michigan for 2021 and 2022. This method ensures that the rates represent the average annual rate for the two-year period but assumes no changes in employment occurred in 2022. Denominator data for industry specific rates were obtained from the Quarterly Census of Employment and Wages (QCEW). The QCEW consist of private ownership data, so data from the Current Employment Statistics (CES) were used to account for the population of Michigan government workers in Education, Health Care and Social Assistance, and Transportation and Warehousing industries.⁹⁻¹⁰ To account for statistical variability with small numbers, rates were not calculated when the number of amputations in an industry was between 1 and 5.

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).¹¹ 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 WDCA 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

All 134 acute care hospitals, including the four Veteran's Administration (VA) medical centers in Michigan complied with the reporting requirement. For 2021, 86 hospitals, for 2022, 76 hospitals, submitted medical records for potential work-related amputations. All other hospitals 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 767 amputations were ascertained. The workers' compensation database contained a total of 384 amputations that were either paid, partially paid, or expected to be paid and 11 non-paid claims: 209 for 2021, 186 for 2022. One hundred and fifty-four of the 767 (20.1%) amputations were only identified in the workers' compensation database (6 of which were non-paid claims). One hundred and twenty-four of the 241 (51.5%) amputations identified in both the workers' compensation database and the hospital

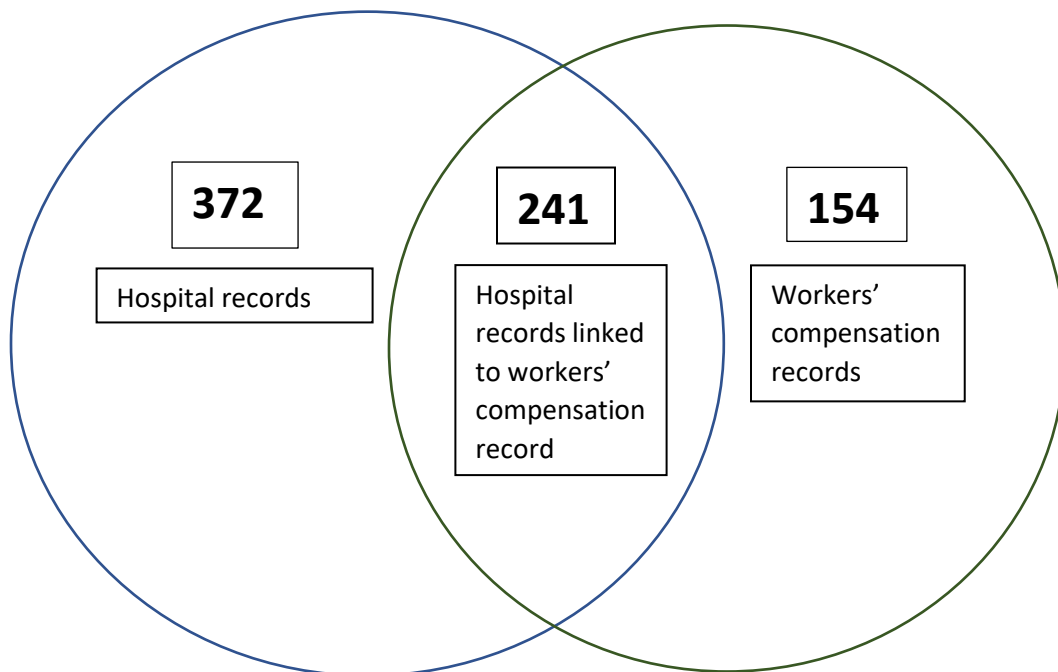
medical records were listed as non-amputation injuries in the workers' compensation database, although they were considered an amputation in the hospital medical records.

TABLE 1: Results of Matching Work-Related Amputations Ascertained from Hospital Medical Records and Workers' Compensation Paid Claims, Michigan, 2021-2022

Paid Injury Claims Within the Final Data Set	Amputation in Hospital Medical Records		
	Yes	No	Total
Yes, With WCDA recorded Amputation Injury	117	154*	271
Yes, In the WCDA records as an injury but not an amputation Injury	124	-	124
Not in WCDA data	372	0	372
Total	613	154	767

**118 paid claims, 22 claims in the process of being paid, 6 claims expected to be paid, 2 claims denied because 7 days lost time criteria not met, and 6 non-paid claims (3 of 6 were verified work-related by another source and 3 were assumed work-related for this report).*

FIGURE 1. Reporting Sources of Work-related Amputations, Michigan 2021-2022



The following sections describe the characteristics of the injured workers and their injuries, as well as the injury source, location, and regulatory outcomes.

Age and Sex

Sex was not available for eight workers. There were 672 (88.5%) men and 87 women (11.5%) who had a work-related amputation. The incidence rate for men was highest in those aged 19–21 years

(25.1/100,000) and for women in those aged 25–34 years (3.2/100,000) (Figure 2). For a further breakdown of amputations by age and sex see Table A-1 in Appendix A.

FIGURE 2. Work-Related Amputation Injury Rates per 100,000 Workers by Age Group and Sex, Michigan 2021-2022*



*Rates were not calculated for female age groups that had 5 or less individuals with an amputation
 Data Sources: Michigan hospital medical records and Michigan Department of LEO WDCA

Race and Hispanic Ethnicity

Of the 613 patients with a hospital medical record indicating an amputation, 229 patients (37.4%) were missing information on race and 355 patients (57.9%) for ethnicity. Workers’ compensation claims do not collect data on race and ethnicity. Among the 384 individuals with information on race, 310 (80.7%) were white, 41 (10.7%) were Black or African American, and 33 (8.6%) were listed as Asian or other unspecified race in the medical record. Among the 258 amputations with data on Hispanic ethnicity, 43 individuals (16.7%) were of Hispanic origin, and 215 individuals (83.3%) were not of Hispanic origin. For a further breakdown of amputations by race and ethnicity see Table A-2 in Appendix A.

Case Study One:

A farm worker in his late 30’s reached into the grinder to remove a jammed plant product that was being fed into the grinder. He suffered an amputation of this thumb at the distal aspect as it was caught and ripped off in the grinder. MIOSHA inspected the farm, and the company was given two citations; one for not disconnecting the grinder from its power source when the employee attempted to remove the jammed plant and the other for failure to record the work-related injury on the MIOSHA form 300. The penalty total was \$6,600.

Body Part and Severity

The majority (94.9%) of the 767 work-related amputations involved fingers (Table 2). Of the 728 finger amputation incidents, 108 (14.8%) involved multiple fingers (Table 3). Medical records provide data on which finger was amputated and how proximal the site of amputation is while workers' compensation claim does not. Of the 574 amputation records with information on which finger was amputated, the index finger had the most amputations with 139 amputations (24.2%). Of the 538 amputations for which the severity of amputation is known, most were Distal amputations, with 460 (85.5%) amputations. Table 3 displays the distribution of digit(s) and section(s) lost among all finger amputations.

TABLE 2: Number and Percent of Work-Related Amputations Occurring in Michigan by Injured Body Part, 2021-2022

Body Part	Number	Percent
Finger	728	94.9%
Hand	4	0.5%
Arm	2	0.3%
Unspecified upper extremity	3	0.4%
Toe	17	2.2%
Foot	0	0.0%
Leg	11	1.4%
Unspecified lower extremity	1	0.1%
Multiple parts	1	0.1%
Total	767	100.0%

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

Case Study Two:

A man in his 50's was working maintenance when his right hand was caught in a pulley bell fan in a conveyor belt while at work. This led to a traumatic amputation to his right ring and right middle finger. MIOSHA inspected the facility, and the facility was given one citation for control of a hazardous energy source. The facility did not have energy control procedures, the authorized employees who were responsible for replacing the pulley bell fan on the return air handling unit did not receive adequate training to identify hazardous energy sources and isolation to protect themselves. In the same citation authorized employees did not utilize lock out of hazardous energy sources and isolation techniques to protect themselves from accident and no yearly inspections on the firm lockout program. This citation total penalty was \$3,500.

TABLE 3: Number and Percent of Work-Related Finger Amputations Occurring in Michigan by Digit and Section of Finger Lost, 2021-2022†

Digit	Section	Number	Percent
Little	Distal	42	7.3%
	Middle	4	0.7%
	Proximal	5	0.9%
	Unknown	4	0.7%
Ring	Distal	58	10.1%
	Middle	3	0.5%
	Proximal	0	0.0%
	Unknown	6	1.0%
Middle	Distal	92	16.0%
	Middle	5	0.9%
	Proximal	3	0.5%
	Unknown	0	0.0%
Index	Distal	117	20.4%
	Middle	10	1.7%
	Proximal	7	1.2%
	Unknown	5	0.9%
Thumb	Distal	78	13.6%
	Proximal	16	2.8%
	Unknown	11	1.9%
Multiple*	Distal	73	12.7%
	Middle	9	1.6%
	Proximal	16	2.8%
	Unknown	10	1.7%
Total	All	574*	100.0%

† Workers' compensation claims do not contain data on section of finger lost and thus the 154 finger amputations identified only through WCDA are excluded from the table.

* Injury section for multiple fingers was based on the most severe injury (i.e. the most proximal injury) that occurred.

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 amputations 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. Ten counties had no residents with work-related amputations. Among the 20 most populous counties in the state (highlighted below), Allegan County had the highest rate (23.7 per 100,000) while Oakland County had the lowest (3.5 per 100,000).

TABLE 4: Number and Average Annual Rate per 100,000 Workers of Work-Related Amputations Occurring in Michigan by County of Residence, 2021-2022†

County	Count	Rate	County	Count	Rate	County	Count	Rate
ALCONA	3	*	GRATIOT	6	29.2	MISSAUKEE	1	*
ALGER	0	0	HILLSDALE	4	*	MONROE	13	18.9
ALLEGAN	18	23.7	HOUGHTON	3	*	MONTCALM	5	*
ALPENA	2	*	HURON	3	*	MONTMORENCY	2	*
ANTRIM	5	*	INGHAM	9	4.3	MUSKEGON	14	13.1
ARENAC	1	*	IONIA	7	24.9	NEWAYGO	7	40.3
BARAGA	1	*	IOSCO	1	*	OAKLAND	49	3.5
BARRY	7	35.9	IRON	2	38.5	OCEANA	5	*
BAY	5	9.5	ISABELLA	3	*	OGE MAW	1	*
BENZIE	0	0	JACKSON	16	14.9	ONTONAGON	2	*
BERRIEN	16	17.5	KALAMAZOO	23	10.8	OSCEOLA	5	*
BRANCH	3	*	KALKASKA	0	0	OSCODA	2	*
CALHOUN	20	22.9	KENT	48	6.4	OTSEGO	1	*
CASS	2	*	KEWEENAW	0	0	OTTAWA	24	11.0
CHARLEVOIX	3	*	LAKE	1	*	PRESQUE ISLE	1	*
CHEBOYGAN	1	*	LAPEER	13	39.7	ROSCOMMON	1	*
CHIPPEWA	1	*	LEELANAU	0	0	SAGINAW	27	19.7
CLARE	1	*	LENAWEE	8	19.5	ST CLAIR	9	12.5
CLINTON	17	48.9	LIVINGSTON	7	6.4	ST JOSEPH	10	29.8
CRAWFORD	0	0	LUCE	0	0	SANILAC	3	*
DELTA	2	*	MACKINAC	2	*	SCHOOLCRAFT	2	*
DICKINSON	2	*	MACOMB	79	12.8	SHIAWASSEE	3	*
EATON	6	7.6	MANISTEE	0	0	TUSCOLA	7	41.9
EMMET	2	*	MARQUETTE	6	14.6	VAN BUREN	6	19.3
GENESEE	20	9.0	MASON	3	*	WASHTENAW	16	6.3
GLADWIN	2	*	MECOSTA	2	*	WAYNE	104	8.4
GOGEBIC	0	0	MENOMINEE	2	*	WEXFORD	0	0
GRAND TRAVERSE	8	9.4	MIDLAND	6	9.3	Unknown	25	N/A
						Out of state	20	N/A
						TOTAL	767	10.7**

†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.

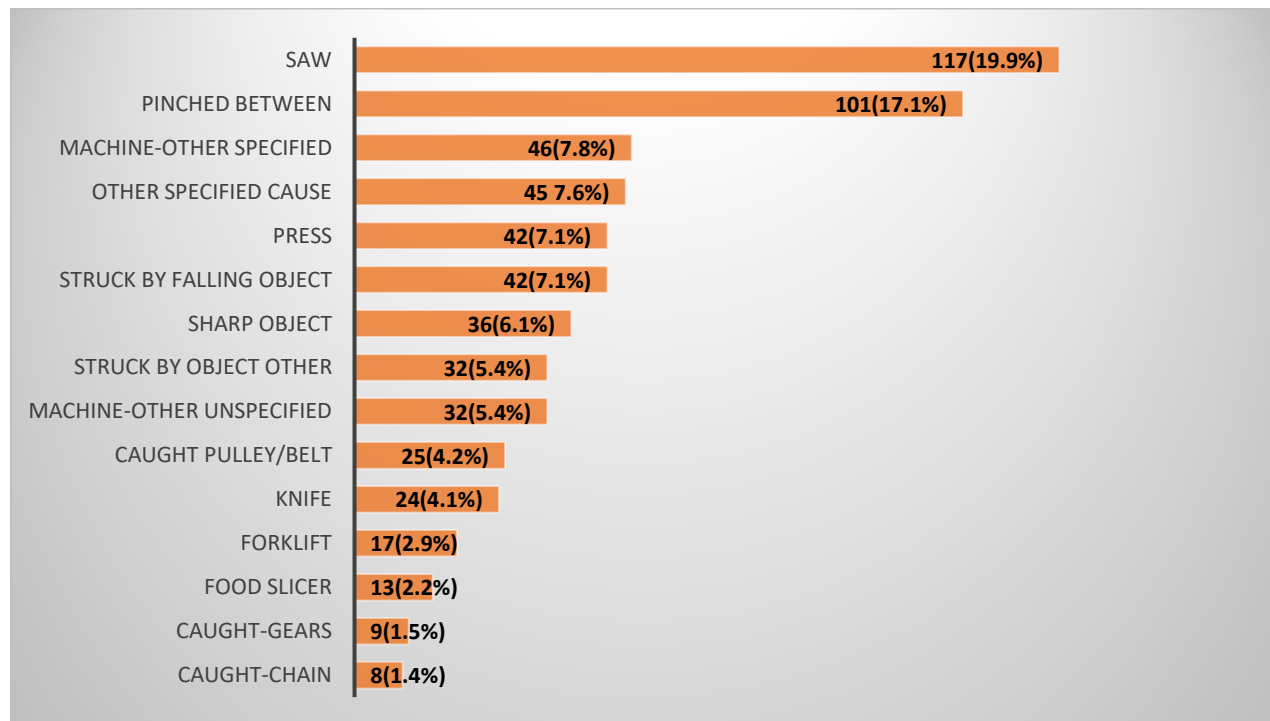
**Rates for total do not include the 20 out of state individuals.

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

Causes of Amputations

Figure 3 displays the number and percentage of work-related amputations by cause of injury. Power saws (e.g., table saws, miter saws) (19.9%) were the most common cause of amputation followed by a digit being pinched between two objects (17.1%). Presses caused 7.1 % of work-related amputations. Other types of machinery, many of which were specified but grouped together due to the variety of machinery, caused 13.2% of amputations. The cause of the amputation was unknown for 178 cases (23.2%), including all 154 cases identified only through workers' compensation claims.

FIGURE 3. Count and percent of Work-Related Amputations Occurring in Michigan by Cause of Injury, 2021-2022*



*Cause of amputation injuries was provided for (76.8%) 589 patients. Figure does not include the 178 unknown cases including the 154 amputations only identified in the workers' compensation data, which does not include cause of injury.

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

Industry

Table 5 shows the number and average annual rate of work-related amputations by industry. There were 221 cases where industry was unknown. Among the main industry sectors, the Agriculture, Forestry, Fishing, and Hunting industry had the highest rate of amputations (22.6 per 100,000 workers). The greatest proportion (43.2%) of amputations in known industries occurred in the Manufacturing Industry. The Wood Products Manufacturing subsector had a considerably higher rate (108.4 per 100,000) than any other subsector. Subsectors with >9 amputations are shown in the table.

TABLE 5: Number and Average Annual Rate per 100,000 Workers of Work-Related Amputations Occurring in Michigan by Industry, 2021-2022

NAICS Code	Industry Classification	Number	Rate
11	Agriculture, forestry, fishing, and hunting	15	22.6
111-112	Crop and animal production	13	3.7
21	Mining, quarrying, and oil and gas extraction	4	*
22	Utilities	2	*
23	Construction	73	20.3
236	Construction of Buildings	21	23.3

NAICS Code	Industry Classification	Number	Rate
237	Heavy and Civil Engineering Construction	10	25.0
238	Foundation, Structure, and Building Exterior Construction	38	16.6
31-33	Manufacturing	236	19.8
311	Food manufacturing	21	26.5
321	Wood products manufacturing	22	108.4
326	Plastics and rubber products manufacturing	12	15.3
331	Primary metal manufacturing	11	30.0
332	Fabricated metal product manufacturing	34	24.0
333	Machinery manufacturing	25	18.3
336	Transportation equipment manufacturing	31	8.4
339	Miscellaneous Manufacturing	23	41.5
42	Wholesale trade	18	5.4
44-45	Retail trade	37	4.1
445	Food and Beverage Retailer	21	13.9
48-49	Transportation and warehousing	24	7.1
51	Information	3	*
52	Finance and insurance	4	*
53	Real estate and rental and leasing	6	5.5
54	Professional, scientific, and technical services	12	2.0
55	Management of companies and enterprises	0	0.0
56	Administrative and support and waste management and remediation services	39	7.3
561	Administrative and Support Services	21	4.2
569	Unknown Administration Services	10	**
61	Educational services	10	1.4
62	Health care and social assistance	9	0.7
71	Arts, entertainment, and recreation	6	6.4
72	Accommodation and food services	29	4.4
722	Restaurants, food service and drinking places	24	0.8
81	Other services (except public administration)	13	5.2
92	Public administration	6	1.2
---	Unknown	221	N/A
---	TOTAL	767	9.1

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

** Number of workers in Industry Unknown Administration Services is not available

Data Source: Michigan hospital medical records

Source of Payment

As shown in Table 6, among patients with a hospital medical record, workers' compensation was the expected payer in 71.4% of the 515 patients with a confirmed source of payment. Payment source could not be determined in the medical records of 99 of the amputations. Among amputations with a known payer that were not initially identified as workers' compensation in the medical records, 15 of the

amputations were linked to a workers' compensation paid (or expected to be paid) claim in the WDCA file; one amputation where the payer in the medical record was self-pay, two where the payer was Medicaid/Medicare , and 12 where the payer was commercial insurance.

TABLE 6: Number and Percent of Work-Related Amputations Occurring in Michigan with a Hospital Medical Record by Payment Source, 2021-2022*

Type of payment	Number	Percent
Workers' Compensation	367	71.4
Commercial insurance	81	15.8
Self-pay	19	3.7
Other	1	0.2
Medicaid/Medicare	47	8.9
Total	515	100

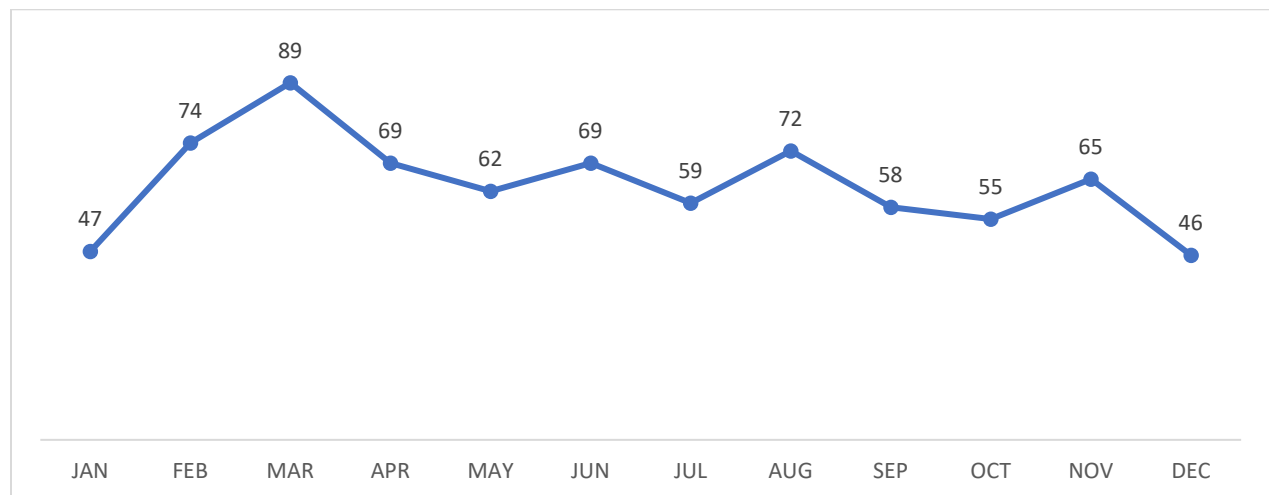
* Excludes 99 amputations, where source of payment was unknown

Data Source: Michigan hospital medical records

Amputations by Month

Work-related amputations occurred most frequently during March and February and were least frequent during January and December (Figure 4).

FIGURE 4. Number of Work-Related Amputations Occurring in Michigan by Month, 2021-2022*



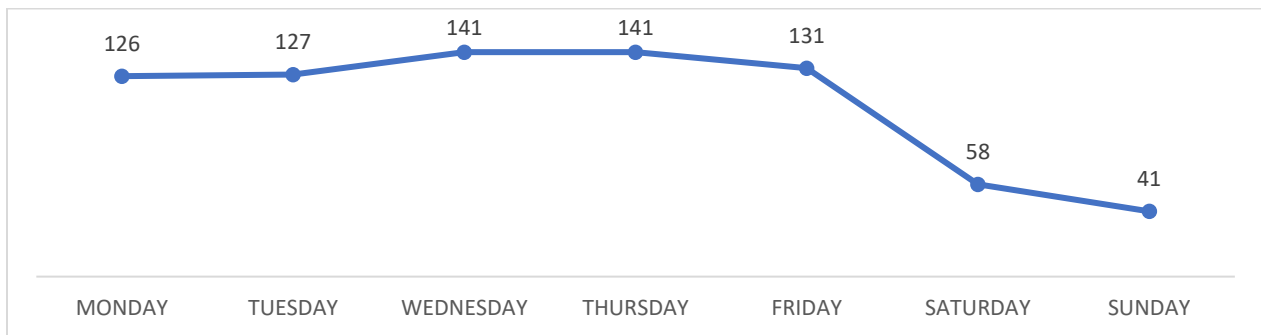
*Excludes 2 work-related amputations cases with an unknown month of injury

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

Amputations by Day

Work-related amputations were more common during the workdays of Monday through Friday and much less common on the weekends (Figure 5).

FIGURE 5. Number of Work-Related Amputations Occurring in Michigan by Weekday, 2021-2022*



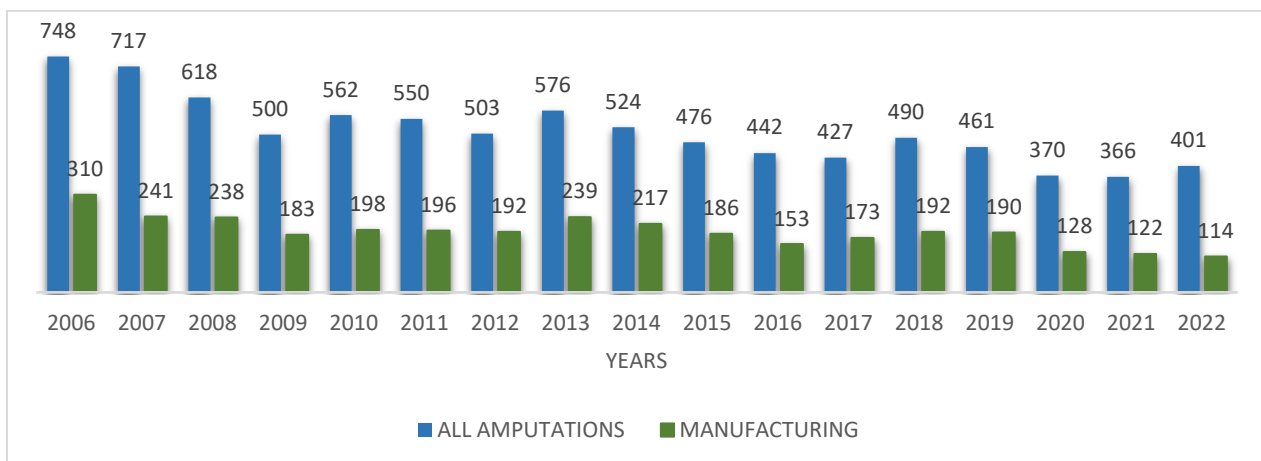
*Excludes 2 work-related amputations cases with an unknown day of injury.

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

Amputations by Year

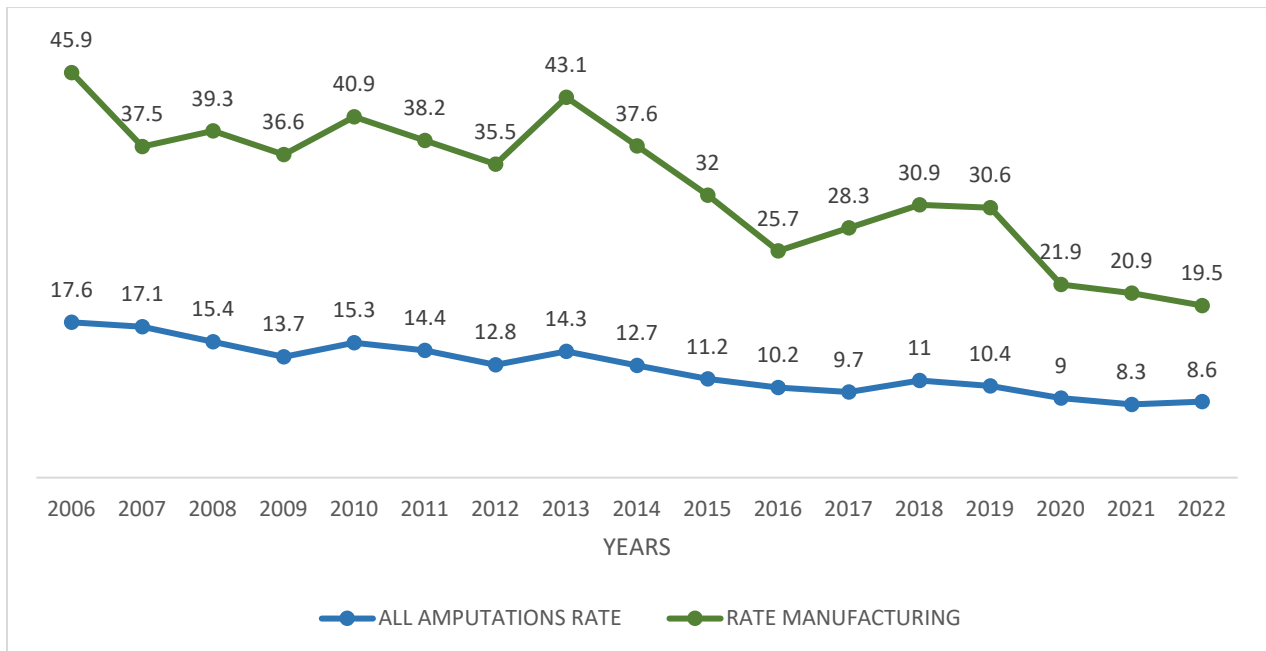
The annual number of amputations decreased by 46.4% during the 17 years the surveillance system has been in place, from 748 in 2006 to 401 in 2022 (Figure 6). In 2020, the relatively low number of amputations presumably reflected stay-at-home orders because of COVID-19. This trend continued into 2021. The number of amputations have risen slightly in 2022. Further reports will look at this trend to indicate if the amputations will level out or return to pre-covid numbers. The rate of amputations also fell from 17.6 per 100,000 workers in 2006 to 8.6 per 100,000 workers in 2022, representing a 51.7% 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, All Injuries and for the Manufacturing Industry, 2006-2022



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

FIGURE 7. Annual Rate per 100,000 workers of Work-Related Amputations Occurring in Michigan by Year, All Injuries and for the Manufacturing Industry, 2006-2022



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

Case Study Three:

A male in his mid-30s had his thumb amputated when he attempted to push meat back into a meat mixer. MIOSHA inspected the worksite and noticed that the large capacity stainless steel meat mixer located in the sausage area of the meat plant did not have a cover over the top of the of the mixer, allowing the employee's hand to enter the point of operation while the mixer was in operation. The company was issued two violations one for not having the cover and another for not reporting the amputation. The total penalties for both violations were \$2,500.

MIOSHA Review

MIOSHA inspected 37 worksites identified from medical records between 2021 and 2022. The number of violations ranged from one to five. Table 8 shows the distribution of assessed penalties. The maximum penalty was \$10,200 and the median was \$3,500. Of the 37 worksites, 30 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 7: Violations Identified in MIOSHA Worksite Inspections*, 2021-2022

Number of Violations	Number of Inspections	Percent
0	7	18.9%
1	5	13.5%
2	13	35.1%
3	7	18.9%
4	2	5.4%
5	3	8.1%
Total	37	100.0%

**Only includes amputations identified from hospital medical records and does not reflect all MIOSHA investigations.
Data Source: Michigan hospital medical records*

TABLE 8: Penalties Assessed in MIOSHA Worksite Inspections*, 2021-2022

Cost of Penalty Assessed	Penalty Assessed	Percent
\$0	1	3.3%
\$1-\$999	3	10.0%
\$1,000-\$4,999	13	43.3%
\$5,000-\$9,999	11	36.7%
\$10,000-\$19,999	2	6.7%
Total	30**	100.0%

**Only includes amputations identified from medical records and does not reflect all MIOSHA investigations.
**Not included in the table are the 7 inspections resulting in zero violations/penalties and the 1 inspection that resulted in 2 violations but zero penalties.
Data Source: Michigan hospital medical records*

Discussion

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 includes 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 2024–2028 Strategic Plan objectives to reduce the rate of worker injuries in high-hazard industries.¹²

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 467 more amputations than BLS SOII from 2021 and 2022. 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 severe 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

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 OEM Division.

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 many records did not include information on the patient's race and Hispanic ethnicity. MSU OEM contacted the hospitals to acquire more details on the extent of patients' race and ethnicity, which is why this report has the lowest percentages of cases with unknown race and ethnicity since the start of the annual reports. For example, this annual report shows that 37.3% of amputations have an unknown race, whereas the previous report, covering 2018-2020, reports 58.1% of amputations with an unknown race.¹¹ However, workers' compensation claims do not collect information on the cause of injury or the worker's race and ethnicity. Workers' compensation claims may also lack detailed injury descriptions (e.g., single vs. multiple digit loss, specific digit injured).

Conclusions

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 Workers of Work-Related Amputations that Occurred in Michigan by Age and Sex, 2021-2022*

Age	Male Count	Male Rate	Age	Female Count	Female Rate
14-18	18	16.4	14-18	2	**
19-21	47	25.1	19-21	5	**
22-24	32	14.4	22-24	7	3.0
25-34	161	17.9	25-34	27	3.2
35-44	126	14.7	35-44	14	1.7
45-54	142	16.8	45-54	15	1.8
55-64	117	15.6	55-64	14	2.0
≥65	29	11.5	≥65	3	**
TOTAL	672	16.3	TOTAL	87	2.2

* 7 workers who did not have a sex assigned in the record and one worker with sex and age unknown were removed

** Rates were suppressed if the count was 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 and Rate per 100,000 Workers of Work-Related Amputations among that Occurred in Michigan by Race and Hispanic Ethnicity, 2021-2022

Race/Ethnicity	Hispanic	Rate	Non-Hispanic	Rate	Unknown*	Total	Total Rate
White	18	5.2	174	2.8	118	310	4.7
Black	1	4.3	26	2.6	14	41	4.0
Other	16	44.5	8	4.3	9	33	13.6
Unknown*	8	N/A	7	N/A	214	229	N/A
TOTAL	43	10.5	215	2.8	355	613**	7.6

* Race or ethnicity data was not recorded in the medical record.

**Does not include the 154 records from workers' compensation as WDCA does not collect race and ethnicity.

Data Source: Michigan hospital medical records.