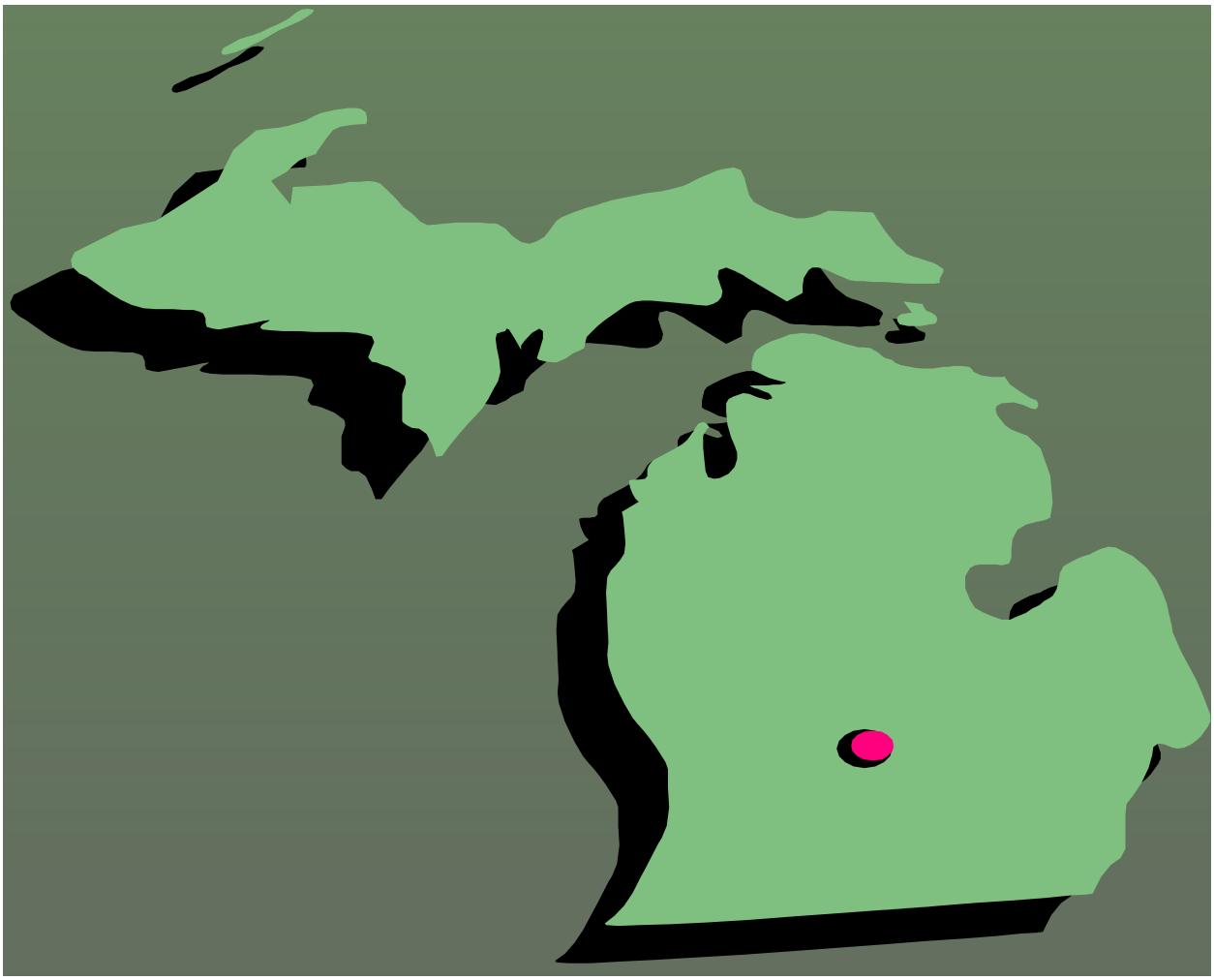
June 20, 2024

# 2022
# Annual Report

## Tracking work-related asthma in Michigan



# 2022 ANNUAL REPORT

## *Work-Related Asthma Surveillance Program*

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There are many resources available to help employers, employees, health care professionals and others understand more about work-related asthma. Links to these resources can be found at: **oem.msu.edu**.

**Acronyms**

**OA** Occupational Asthma

**AA** Work-Aggravated Asthma

**POA** Possible Occupational Asthma

**RADS** Reactive Airways Dysfunction Syndrome

**LARA** MI Department of Licensing & Regulatory Affairs

**LEO** MI Department of Labor & Economic Opportunity

**MIOSHA** Michigan Occupational Safety & Health Administration

**NAICS** North American Industrial Classification System

**NIOSH** National Institute for Occupational Safety & Health

**PEL** Permissible Exposure Limit

**REL** Recommended Exposure Limit

**This report was funded by the National Institute for Occupational Safety & Health, under cooperative agreement U60-OH008466.**

***We sincerely appreciate the commitment of those health care providers who understand the public health significance of diagnosing a patient with an occupational illness, as well as the Michigan employees who took the time to share their experiences about their work and subsequent development of work-related asthma.***

## *Summary*

This is the 32nd annual report on work-related asthma (WRA) in Michigan.

In 2010, in a publication in the Journal of Asthma, researchers found that in a random sample of Michigan adults, 54.1% self-reported that their asthma was caused or aggravated by their work, and yet only 22% reported having a discussion with their health care provider about their concern about the effect of work on their asthma[1]. These same individuals were more symptomatic and had more health care usage than other Michigan adults with asthma. This study highlights the importance of health care providers considering whether their patients with asthma have work-related triggers.

- From 1988-2022, 3,954 WRA cases have been identified with MI's tracking system.
- We estimate there are 62,000-97,000 adults in MI with WRA.
- 77% of the MI WRA patients have new-onset asthma; 23% have pre-existing asthma aggravated by an exposure at work.
- MIOSHA enforcement inspections at the facilities where individuals worked who were reported with WRA revealed that, on average, almost one out of every six of the fellow workers have asthma or respiratory symptoms compatible with asthma.
- Cleaning agents (13.5%) and isocyanates (12.0%), are the most commonly reported exposures causing WRA in MI.
- The average incidence rate of WRA among Black/African American workers is 2.5 times greater than that of White workers.

**There are over 300 known asthma-causing agents used in the workplace. Thousands more substances have not been evaluated for their asthma-causing potential. The Association of Occupational & Environmental Clinics (AOEC) has a web site with an on-line look-up feature to identify asthma-causing agents at: aoec.org**

# *Background*

In 1988, the State of Michigan instituted a tracking program for WRA with financial assistance from NIOSH. This is a joint project of MIOSHA (LEO) and Michigan State University (MSU), Department of Medicine, Division of Occupational and Environmental Medicine.

The reporting of an index patient is a sentinel health event that may lead to the identification of employees from the same facilities who are also at risk of developing asthma or who have developed similar breathing problems. The goal is to prevent WRA through the identification and workplace follow-up of these index patients.

# *Work-Related Asthma Tracking Procedures*

Patients are identified through mandatory reporting of any known *or suspected* occupational illnesses, including WRA.

**SOURCES TO IDENTIFY PATIENTS**

- **Health Care Providers:** private practice, and those working for industry
- **Hospitals** ICD-10 J45 and Workers' Compensation payer
- **Workers' Compensation Agency**
- **Poison Control Center**
- **Reports from Co-Workers or MIOSHA Field Staff** confirmed by a health care provider
- **Death Certificates**
- **Clinical Laboratories for specific IgE Allergy Testing**
- **Michigan Emergency Medical Services Information System (MI-EMSIS)**

**Part 56 of the Michigan Public Health Code requires reporting of all known or suspected occupational illnesses or work-aggravated health conditions to the Michigan Department of Labor & Economic Opportunity *within 10 days of discovery*.**

# *WRA Tracking Procedures in Michigan*

**STEP 1. IDENTIFY PATIENTS** — Occupational Disease Reports submitted to LEO are reviewed. Any known or suspected WRA cases are identified. A letter is sent to the patient to invite them to participate in a telephone interview.

**STEP 2. INTERVIEW PATIENTS —** A telephone interview with the suspected WRA patient is conducted, and medical records are obtained, including any pulmonary function test results. A physician who is board-certified in internal medicine and occupational medicine reviews all collected information.

**STEP 3. CONFIRM DIAGNOSIS OF WRA*** — The diagnosis of WRA requires **A)** Physician diagnosis of asthma and **B)** Onset of respiratory symptoms associated with a particular job that resolve or improve away from work and **C)** Work with a known allergen, or an association between the work exposure and a decrease in peak flow or spirometry.

**STEP 4. WORKPLACE INSPECTION** — After the patient interview is completed and the work-relatedness is determined, an onsite MIOSHA workplace enforcement inspection may be conducted. **During an Inspection:** Co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure to the allergen. Air monitoring for any suspected allergens may be conducted. The company's health and safety programs are reviewed, including its Injury & Illness Log and medical program.

**STEP 5. FOLLOW-UP ACTIVITIES —** After the investigation is complete, a report of air sampling results and any recommendations is sent to the company and made available to workers. A copy of the report is also sent to the reporting physician. Letters are sent to any workers who reported breathing problems in relation to work or new-onset asthma since working at the facility. The letters recommend they seek medical care to determine the cause of their breathing problems.

**STEP 6. ADDITIONAL FOLLOW-UP —** Outreach, educational activities, and recommendations may be developed based on the findings. An annual report summarizing the activity is completed each year.

***SUBCATEGORIES OF WRA**

**<u>New Onset</u>**

**1) Occupational Asthma (OA) if A), B), and C) are met.**

**2) Possible WRA (POA) if only A) and B) are met.**

**3) Reactive Airways Dysfunction Syndrome (RADS) if symptoms develop after an acute exposure.[2]**

**<u>Exacerbation</u>**

**4) Work-Aggravated Asthma (AA) if had asthma in the 2 years prior to job, but asthma worsens at work.**

# *Results*

The following sections report the cumulative results of WRA surveillance from 1988 to-date.

**REPORTS**

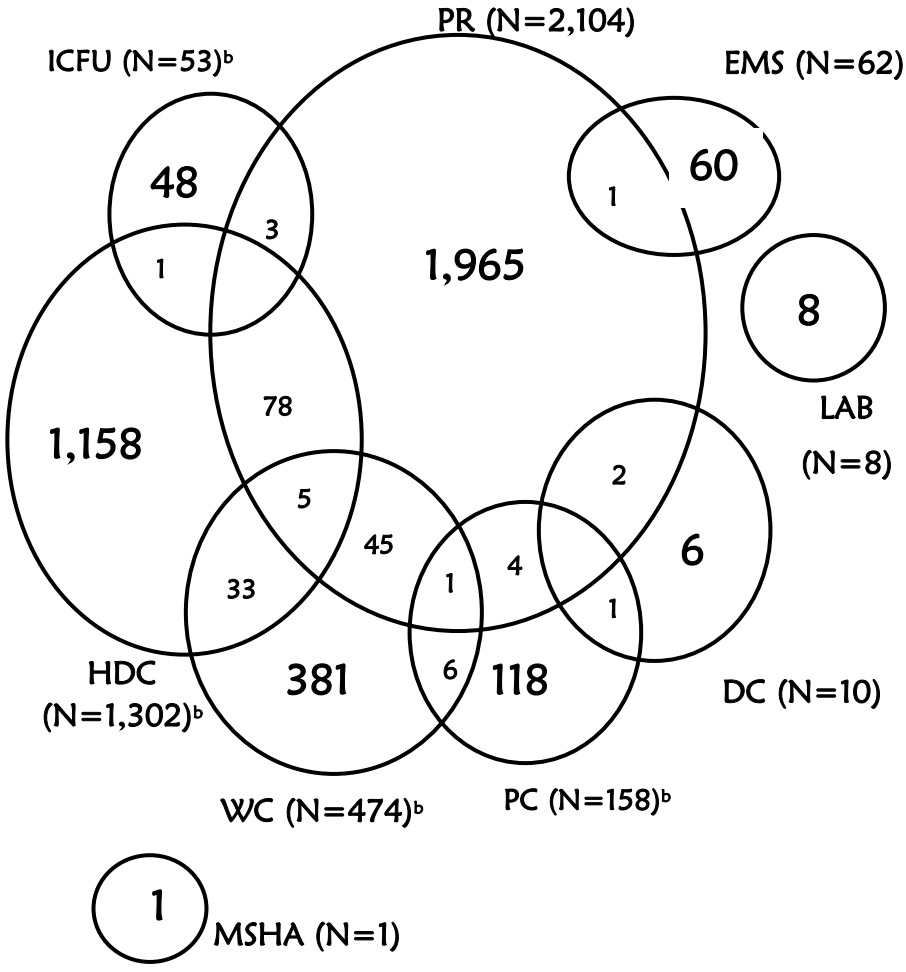
Table 1 shows that 3,954 people were confirmed with WRA between 1988—2022. The reports are divided into: occupational asthma (OA), possible occupational asthma (POA), aggravated asthma (AA) and Reactive Airways Dysfunction Syndrome (RADS). Seventy-two additional patients have been confirmed since last year's report (all 72 for 2022). Figure 1 shows the overlap of the patients by reporting sources for 1988—2022.

## TABLE 1
## Number of Confirmed Cases of WRA by Year and Type

| | Disease Status | | | | |
|---|---|---|---|---|---|
| YEAR | OA | POA | AA | RADS | TOTAL |
| 1988 | 23 | 7 | 0 | 1 | 31 |
| 1989 | 43 | 12 | 3 | 5 | 63 |
| 1990 | 87 | 35 | 14 | 8 | 144 |
| 1991 | 55 | 30 | 14 | 16 | 115 |
| 1992 | 81 | 36 | 14 | 18 | 149 |
| 1993 | 76 | 68 | 13 | 19 | 176 |
| 1994 | 65 | 59 | 15 | 13 | 152 |
| 1995 | 57 | 34 | 19 | 17 | 127 |
| 1996 | 61 | 59 | 24 | 11 | 155 |
| 1997 | 53 | 74 | 19 | 16 | 162 |
| 1998 | 48 | 72 | 18 | 9 | 147 |
| 1999 | 49 | 65 | 16 | 12 | 142 |
| 2000 | 49 | 67 | 31 | 17 | 164 |
| 2001 | 51 | 50 | 20 | 19 | 140 |
| 2002 | 40 | 58 | 24 | 21 | 143 |
| 2003 | 30 | 63 | 28 | 23 | 144 |
| 2004 | 39 | 61 | 37 | 30 | 167 |
| 2005 | 44 | 65 | 21 | 23 | 153 |
| 2006 | 34 | 61 | 29 | 14 | 138 |
| 2007 | 20 | 41 | 34 | 28 | 123 |
| 2008 | 20 | 49 | 25 | 16 | 110 |
| 2009 | 21 | 40 | 31 | 8 | 100 |
| 2010 | 18 | 39 | 30 | 16 | 103 |
| 2011 | 21 | 24 | 19 | 3 | 67 |
| 2012 | 17 | 19 | 35 | 10 | 81 |
| 2013 | 17 | 25 | 37 | 6 | 85 |
| 2014 | 17 | 21 | 27 | 2 | 67 |
| 2015 | 16 | 21 | 33 | 13 | 83 |
| 2016 | 21 | 14 | 38 | 6 | 79 |
| 2017 | 10 | 24 | 43 | 5 | 82 |
| 2018 | 21 | 12 | 52 | 3 | 88 |
| 2019 | 18 | 23 | 41 | 12 | 94 |
| 2020 | 8 | 11 | 25 | 2 | 46 |
| 2021 | 9 | 10 | 39 | 4 | 62 |
| 2022 | 12 | 13 | 44 | 3 | 72 |
| Total | 1,251 | 1,362 | 912 | 429 | 3,954 |

[a]Reports are still being processed for calendar years 2021 and 2022 an increase in these totals will be reflected in next year's annual report.

## FIGURE 1
## Overlap of Reporting Sources for 3,954 Confirmed WRA Patients: 1988-2022[a]




[a]Ns represent the total number for that source. Reporting Source: HDC=Hospital Discharge; PR=Physician Referral; DC=Death Certificate; WC=Workers' Compensation; ICFU=Index Case Follow-Up; MSHA=Mine Safety & Health Administration; PC=Poison Control Center; LAB= Laboratory IgE. EMS= MI Emergency Medical Services (Ambulance)

[b]There was an overlap of PC-HDC for 25 individuals, an overlap of one individual each for PC-ICFU, WC-DC, EMS-HDC, and an overlap of WC-PC-HDC for two individuals.

# *Demographics – Trends*

The analyses conducted for the annual report were divided into 1988-1997, 1998-2007, 2008-2017 and 2018-2022 to examine trends over time. There were 1,274 individuals reported with work-related asthma from 1988-1997, 1,461 individuals reported from 1998-2007, 857 reported from 2008 to 2017 and 362 reported from 2018-2022. The trend analyses can be found along with the tables that present the overall statistics. The "Change in Percentage" column on select tables indicates the percentage of increase or decrease in the percentages from the 1988-1997 to the 2018-2022 time periods.

**GENDER:** Table 2 shows that a higher percentage of women were reported with work-related asthma compared to men. In the 1998-2007 and 2008-2017 periods, the percentage of women reported with WRA increased, while the percentage of men decreased. The percentage by gender in 2018-2022 is similar to the percentage in 1988-1997.

**RACE:** Table 3 shows there was an increase over time in the percentage of Hispanic and Black/African American cases of WRA, and a decrease in the percentage of White cases of WRA. The percentages of other races remained unchanged over time, although the numbers of cases of other races were quite low. The annual incidence rate was 2.70 per 100,000 Michigan Black/African American workers compared to 1.09 per 100,000 Michigan White workers; this was a 2.5 times greater incidence (95% CI 1.412, 4.343). Historically, in our surveillance program, Hispanic ethnicity was not collected. To date, we have identified 89 cases of WRA of Hispanic ethnicity, although that is likely an undercount because of incomplete data.

**TABLE 2**
**Gender of WRA Patients by Time Period**

| | | Time Period | | | | |
|---|---|---|---|---|---|---|
| | All years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | Change in Percentage |
| **Gender** | # (%) | # (%) | # (%) | # (%) | # (%) | |
| Female | 2,135 (54) | 626 (49) | 800 (55) | 519 (61) | 190 (52) | +6% |
| Male | 1,819 (46) | 648 (51) | 661 (45) | 338 (39) | 172 (48) | - 6% |

**TABLE 3**
**Race of WRA Patients by Time Period**

| | | Time Period | | | | |
|---|---|---|---|---|---|---|
| | All years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | Change in Percentage |
| **Race** | # (%) | # (%) | # (%) | # (%) | | |
| White | 2,886 (73) | 997 (78) | 1,093 (75) | 602 (70) | 194 (54) | -31% |
| Black/African American | 773 (20) | 239 (19) | 272 (19) | 162 (19) | 100 (28) | +47% |
| Alaskan/Am Indian | 34 (1) | 10 (1) | 13 (1) | 7 (1) | 4 (1) | None |
| Asian | 15 (<1) | 4 (0.3) | 7 (0.5) | 4 (0.5) | 0 -- | NA |
| Other | 55 (1) | 11 (1) | 27 (1) | 13 (2) | 4 (1) | None |
| Unknown | 191 (5) | 13 (1) | 49 (3) | 69 (8) | 60 (17) | N/A |

# *Location in State – Trends*

Table 4 and Figure 2 show the average annual incidence rates of WRA among the working population, by county. The highest rates were in Luce (9.4 cases per 100,000), Clare (7.2 cases per 100,000), Huron (5.2 cases per 100,000), Montmorency (4.9 cases per 100,000), Osceola (4.6 cases per 100,000), Genesee (4.5 cases per 100,000), Baraga (4.4 cases per 100,000) and Saginaw (4.3 cases per 100,000).

**TABLE 4**

**Average Annual Incidence Rates of WRA Among Michigan Workers by County of Exposure: 1989-2020[a]**

| County | Avg Annual # EE's[b] | Avg Annual Rate[c] | Cases 1989-2020 | County | Avg Annual # EE's[b] | Avg Annual Rate[c] | Cases 1989-2020 |
|---|---|---|---|---|---|---|---|
| Alcona | 3,734 | 0.8 | 1 | Keweenaw | 944 | 3.3 | 1 |
| Alger | 4,048 | 2.3 | 3 | Lake | 3,998 | 1.6 | 2 |
| Allegan | 49,958 | 3.5 | 56 | Lapeer | 41,905 | 2.9 | 39 |
| Alpena | 13,970 | 2.5 | 11 | Leelanau | 10,874 | 2.0 | 7 |
| Antrim | 11,088 | 1.4 | 5 | Lenawee | 45,730 | 2.5 | 36 |
| Arenac | 7,103 | 3.1 | 7 | Livingston | 89,055 | 1.4 | 41 |
| Baraga | 3,556 | 4.4 | 5 | Luce | 2,654 | 9.4 | 8 |
| Barry | 28,596 | 1.1 | 10 | Mackinac | 5,885 | 2.7 | 5 |
| Bay | 51,802 | 1.7 | 29 | Macomb | 396,780 | 2.5 | 315 |
| Benzie | 8,227 | 1.5 | 4 | Manistee | 10,779 | 1.2 | 4 |
| Berrien | 72,422 | 1.3 | 31 | Marquette | 32,565 | 2.2 | 23 |
| Branch | 21,277 | 3.8 | 26 | Mason | 13,773 | 1.6 | 7 |
| Calhoun | 66,888 | 2.6 | 56 | Mecosta | 18,531 | 1.5 | 9 |
| Cass | 25,616 | 0.6 | 5 | Menominee | 12,597 | 0.2 | 1 |
| Charlevoix | 13,105 | 2.4 | 10 | Midland | 38,738 | 2.8 | 35 |
| Cheboygan | 11,681 | 3.5 | 13 | Missaukee | 6,201 | 2.5 | 5 |
| Chippewa | 15,906 | 1.4 | 7 | Monroe | 72,474 | 1.5 | 35 |
| Clare | 12,133 | 7.2 | 28 | Montcalm | 27,319 | 2.1 | 18 |
| Clinton | 34,977 | 0.9 | 10 | Montmorency | 3,817 | 4.9 | 6 |
| Crawford | 6,234 | 3.0 | 6 | Muskegon | 82,728 | 1.1 | 28 |
| Delta | 18,700 | 2.0 | 12 | Newaygo | 21,238 | 2.6 | 18 |
| Dickinson | 13,496 | 3.5 | 15 | Oakland | 606,421 | 2.4 | 463 |
| Eaton | 55,176 | 0.7 | 13 | Oceana | 12,741 | 1.7 | 7 |
| Emmet | 18,249 | 1.4 | 8 | Ogemaw | 8,987 | 3.5 | 10 |
| Genesee | 194,369 | 4.5 | 277 | Ontonagon | 3,300 | 0.9 | 1 |
| Gladwin | 9,983 | 0.9 | 3 | Osceola | 9,575 | 4.6 | 14 |
| Gogebic | 7,217 | 1.3 | 3 | Otsego | 11,720 | 2.9 | 11 |
| Gd Traverse | 44,511 | 1.6 | 23 | Ottawa | 126,705 | 0.8 | 34 |
| Gratiot | 18,680 | 2.0 | 12 | Roscommon | 10,306 | 2.4 | 8 |
| Hillsdale | 20,675 | 2.0 | 13 | Saginaw | 90,548 | 4.3 | 125 |
| Houghton | 16,137 | 1.5 | 8 | Sanilac | 19,894 | 3.3 | 21 |
| Huron | 15,636 | 5.2 | 26 | Schoolcraft | 3,588 | 1.7 | 2 |
| Ingham | 143,327 | 3.2 | 146 | Shiawassee | 33,900 | 0.6 | 7 |
| Ionia | 28,133 | 1.6 | 14 | St. Clair | 78,920 | 2.5 | 62 |
| Iosco | 9,617 | 1.6 | 5 | St. Joseph | 28,932 | 1.5 | 14 |
| Iron | 5,480 | 2.3 | 4 | Tuscola | 26,833 | 2.8 | 24 |
| Isabella | 35,007 | 2.7 | 30 | Van Buren | 37,417 | 0.9 | 11 |
| Jackson | 72,274 | 2.4 | 55 | Washtenaw | 179,602 | 3.5 | 203 |
| Kalamazoo | 123,752 | 1.5 | 58 | Wayne | 837,179 | 3.2 | 869 |
| Kalkaska | 8,036 | 3.5 | 9 | Wexford | 13,468 | 1.6 | 7 |
| Kent | 297,020 | 1.2 | 113 | ***All Counties[d]*** | **4,706,000[e]** | **2.5** | **3,706** |

[a] 1989 through 2020 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2021 and 2022 is not yet complete. Therefore, 1988, 2021 and 2022 reports are not included in this table.

[b] EE's =employees. Source: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 2004. Accessed 6/30/2020.

[c] Rates are based on the average number of cases per year from 1989-2020 (32 years), per 100,000 Michigan workers.

[d] Sixty-one cases had an out-of-state exposure and 22 had an unknown county of exposure, for the 1989-2020 reporting period.

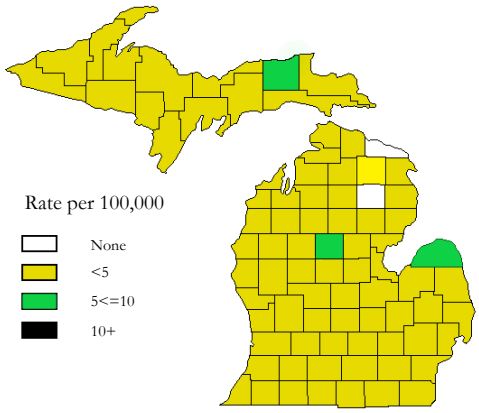
[e] Total is rounded up.

# *Type of Industry – Trends*

**TOP COUNTIES:** Table 5 shows the top 11 counties with the highest overall rates of WRA that had more than one case during the 1989-2020 time period. Six of the top counties with the highest overall rates of WRA had a decrease of 10% or greater, while four counties, Huron, Montmorency, Oscoda and Saginaw, had an increase in the rate of WRA over time. In eight of the counties, the rates increased during the 1998-2007 time period, but in five counties the rate decreased during the 2018-2022 time period.

Table 6 shows the Michigan industries by NAICS

**FIGURE 2**
**Average Annual Incidence Rate of WRA by County of Exposure: 1989-2020[a]**




[a] 1989 through 2020 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2021 and 2022 is not yet complete. Therefore, 1988, 2021 and 2022 reports are not included in this figure.

**TABLE 5**
**Average Annual Incidence Rate[a] of WRA per 100,000 Workers by County and Time Period**

| | | Time Period | | | | |
|---|---|---|---|---|---|---|
| | All Years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | |
| **County** | Rate | Rate | Rate | Rate | Rate | Change in Percentage |
| Branch | 3.5 | 4.0 | 5.6 | 2.9 | 3.3 | - 18% |
| Cheboygan | 3.5 | 8.3 | 1.8 | 3.2 | -- | - 61% |
| Clare | 7.2 | 8.8 | 9.4 | 7.5 | 5.8 | - 34% |
| Genesee | 4.5 | 4.6 | 6.8 | 3.1 | 2.8 | - 39% |
| Huron | 5.2 | 4.7 | 5.2 | 3.3 | 9.9 | + 111% |
| Kalkaska | 3.5 | 6.5 | 5.1 | -- | 2.9 | - 55% |
| Luce | 9.4 | 19.8 | 7.5 | 9.4 | -- | - 53% |
| Montmorency | 4.9 | -- | 5.3 | 11.0 | 7.7 | + 45% |
| Osceola | 4.6 | 2.1 | 9.8 | 1.1 | 3.8 | + 81% |
| Saginaw | 4.3 | 3.4 | 7.4 | 2.3 | 3.7 | + 9% |
| Sanilac | 3.3 | 2.8 | 6.0 | 1.7 | 2.3 | - 18% |
| All MI Counties | 2.5 | 3.0 | 3.1 | 2.0 | 1.7 | - 43% |

[a] Denominator source (data not shown): MI Dept. of Tech. Mgt & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, for the 1988-1997 time period were calculated using 1992 employment data, for 1998-2007 using 2002 employment data, for 2008-2017 using 2012 data, and for 2018-2022 using 2020 data, accessed 5-29-2024.

codes, with cases of work-related asthma from 1988 to 2022. The main industries were in manufacturing (55%) and health care and social assistance (12%).

The incidence rate of WRA by industry ranges from 0.1 cases per 100,000 in management of companies to a high of 9.4 cases per 100,000 in manufacturing. Industries with the next highest average annual incidence rates were: mining with 6.3 cases per 100,000 workers and health care and social assistance with 3.1 cases per 100,000 workers.

Table 7 shows the average annual incidence rates for WRA cases *within manufacturing.*

**INDUSTRIES OVER TIME:** Table 8 shows distribution across all industries for the WRA cases by time period. There was a large decrease in the percentage of WRA cases in manufacturing, which dropped from 71.6% of cases in 1988-1997 to 39.8% in 2018-2022. There were also decreases in mining and wholesale trade. There were increases in all other industries from 1988-1997 to 2018-2022.

## TABLE 6
## Number of WRA Patients, 1988-2022 by Primary Industrial Exposure and Average Annual Incidence Rate per 100,000 Workers, 1989-2020 (Years of Complete Reporting)

| 2002 N American Industry Classification System | | WRA Cases 1988-2022 | | Number of Employees[a] | Average Ann. Incidence Rate[b] | |
|---|---|---|---|---|---|---|
| | | # | % | | Rate | # Cases |
| 11 | Agriculture, Forestry, Fishing, & Hunting | 38 | 1.0 | 79,883 | 1.2 | 30 |
| 21 | Mining | 14 | 0.4 | 6,400 | 6.3 | 13 |
| 22 | Utilities | 23 | 0.6 | 35,300 | 2.0 | 23 |
| 23 | Construction | 114 | 2.9 | 189,690 | 1.7 | 103 |
| 31-33 | Manufacturing | 2,176 | 55.0 | 695,885 | 9.4 | 2,093 |
| 42 | Wholesale Trade | 44 | 1.1 | 169,735 | 0.8 | 41 |
| 44-45 | Retail Trade | 134 | 3.4 | 512,474 | 0.8 | 127 |
| 48-49 | Transportation & Warehousing | 85 | 2.1 | 100,137 | 2.5 | 79 |
| 51 | Information | 25 | 0.6 | 67,973 | 1.1 | 24 |
| 52 | Finance & Insurance | 36 | 0.9 | 156,375 | 0.7 | 37 |
| 53 | Real Estate & Rental & Leasing | 20 | 0.5 | 56,094 | 1.1 | 19 |
| 54 | Professional, Scientific & Technical Svcs | 34 | 0.9 | 244,858 | 0.4 | 34 |
| 55 | Mgt of Companies & Enterprises | 2 | 0.1 | 67,988 | 0.1 | 2 |
| 56 | Administrative & Support & Waste Mgt | 99 | 2.5 | 271,673 | 1.1 | 93 |
| 61 | Educational Services | 175 | 4.4 | 437,200 | 1.2 | 170 |
| 62 | Health Care & Social Assistance | 491 | 12.4 | 480,330 | 3.1 | 475 |
| 71 | Arts, Entertainment & Recreation | 35 | 0.9 | 61,137 | 1.7 | 34 |
| 72 | Accommodation & Food Services | 128 | 3.2 | 339,052 | 1.1 | 124 |
| 81 | Other Services (except Public Admin) | 98 | 2.5 | 178,600 | 1.6 | 94 |
| 92 | Public Administration | 157 | 4.0 | 252,700 | 1.8 | 149 |
| 00 | Unknown | 26 | 0.7 | -- | -- | 25 |
| **Total** | | 3,954 | | 4,456,600 | 2.7 | 3,789 |

[a]Source: MI Dept of Tech, Mgt & Budget, Labor Market Information, Industry Employment (CES), 2004. Accessed 6/30/2020. The total non-farm employment in MI, 2004: 4,456,600. Agriculture: 2004 U.S. Census of Agriculture-State Data. Total Farm Employment. Denominator Source for Mining, Utilities, Education, Public Administration and Other Services: MDLEG Office of LMI, Industry Employment Series, MI, 2004, accessed 6/23/2005.

[b]Reporting in 1988 was begun mid-year and reporting for 2021 and 2022 is not yet complete. Therefore, 1988, 2021 and 2022 reports are not included in the calculation of the annual average incidence rate. Rates are based on the average number of cases by industry from 1989-2020 (32 years), per 100,000 Michigan workers.

## TABLE 7
## 2,093 WRA Patients from Manufacturing Industries: 1989-2020[a]

| 2002 North American Industry Classification System | | # WRA Cases | Avg Ann Rate[a] | # Employees[b] |
|---|---|---|---|---|
| 311 | Food Mfg | 74 | 7.1 | 32,729 |
| 323 | Printing & Related Support Activities | 19 | 3.2 | 18,327 |
| 325 | Chemical Mfg | 112 | 12.6 | 27,704 |
| 326 | Plastics & Rubber Products Mfg | 122 | 8.9 | 43,056 |
| 327 | Nonmetallic Mineral Product Mfg | 19 | 3.6 | 16,512 |
| 331 | Primary Metal Mfg | 73 | 8.3 | 27,648 |
| 332 | Fabricated Metal Product Mfg | 129 | 4.8 | 83,121 |
| 333 | Machinery Mfg | 160 | 6.6 | 75,925 |
| 334 | Computer & Electronic Product Mfg | 16 | 2.6 | 19,165 |
| 336 | Transportation Equipment Mfg | 1,191 | 14.5 | 255,913 |
| 337 | Furniture & Related Product Mfg | 17 | 2.0 | 26,167 |
| | Miscellaneous Mfg (*includes NAICS: 312-16,321-322,324,335,339) | 161 | 7.2 | 69,619 |

[a]Average annual incidence rate, based on cases from 1989-2020 (32 years) per 100,000 adult workers in Michigan in each industrial category and represents years with complete reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2021 and 2022 is not yet complete. Therefore, 1988, 2021 and 2022 reports are not included in this table.

[b]Source: Michigan Department of Technology, Management and Budget, Labor Market Information, Industry Employment and Wages-QCEW, 2004. Accessed 7/1/2020.

## TABLE 8
## Industry of WRA Patients by Time Period

| | | Time Period | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1988-1997 | | 1998-2007 | | 2008-2017 | | 2018-2022 | | |
| NAICS | Industry | # | % | # | % | # | % | # | % | Change in Percentage |
| 11 | Agr, Forestry, Fishing, & Hunting | 4 | 0.3 | 12 | 0.8 | 8 | 0.9 | 13 | 3.6 | + 1100% |
| 21 | Mining | 5 | 0.4 | 6 | 0.4 | 2 | 0.2 | 1 | 0.3 | - 25% |
| 22 | Utilities | 3 | 0.2 | 5 | 0.3 | 11 | 1.3 | 2 | 0.6 | + 200% |
| 23 | Construction | 32 | 2.5 | 37 | 2.5 | 30 | 3.5 | 15 | 4.1 | + 64% |
| 31-33 | Manufacturing | 912 | 71.6 | 809 | 55.4 | 313 | 36.5 | 144 | 39.8 | - 44% |
| 42 | Wholesale Trade | 23 | 1.8 | 14 | 1.0 | 3 | 0.4 | 5 | 1.4 | - 22% |
| 44-45 | Retail Trade | 15 | 1.2 | 48 | 3.3 | 51 | 6.0 | 18 | 5.0 | + 317% |
| 48-49 | Transportation & Warehousing | 14 | 1.1 | 35 | 2.4 | 21 | 2.5 | 15 | 4.1 | + 273% |
| 51 | Information | 6 | 0.5 | 11 | 0.8 | 7 | 0.8 | 1 | 0.3 | - 40% |
| 52 | Finance & Insurance | 2 | 0.2 | 17 | 1.2 | 15 | 1.8 | 2 | 0.6 | + 200% |
| 53 | Real Estate & Rental & Leasing | 2 | 0.2 | 11 | 0.8 | 6 | 0.7 | 1 | 0.3 | + 50% |
| 54 | Professional, Scientific & Tech Svcs | 9 | 0.7 | 16 | 1.1 | 6 | 0.7 | 4 | 1.1 | + 57% |
| 55 | Mgt of Companies & Enterprises | 0 | — | 1 | 0.1 | 1 | 0.1 | 0 | -- | N/A |
| 56 | Admin & Support & Waste Mgt | 10 | 0.8 | 27 | 1.8 | 40 | 4.7 | 24 | 6.6 | + 725% |
| 61 | Educational Services | 40 | 3.1 | 73 | 5.0 | 50 | 5.8 | 12 | 3.3 | + 6% |
| 62 | Health Care & Social Assistance | 105 | 8.2 | 194 | 13.3 | 145 | 16.9 | 45 | 12.4 | + 51% |
| 71 | Arts, Entertainment & Recreation | 5 | 0.4 | 11 | 0.8 | 15 | 1.8 | 3 | 0.8 | + 100% |
| 72 | Accommodation & Food Services | 19 | 1.5 | 49 | 3.4 | 42 | 4.9 | 18 | 5.0 | + 233% |
| 81 | Other Svcs (except Public Admin) | 22 | 1.7 | 31 | 2.1 | 29 | 3.4 | 17 | 4.7 | + 176% |
| 92 | Public Administration | 44 | 3.5 | 46 | 3.1 | 51 | 6.0 | 17 | 4.7 | + 34% |
| 00 | Unknown | 2 | 0.2 | 8 | 0.5 | 11 | 1.3 | 5 | 1.4 | N/A |

# *Type of Exposure – Trends*

Table 9 shows the exposures associated with WRA among Michigan workers. The most frequent exposures reflect the widespread use of cleaning products across all industry sectors and the importance of the automotive manufacturing industry in the State. Most frequently identified exposures include cleaning products, associated with 532 (13.5%) of Michigan's WRA patients, and isocyanates (MDI, TDI, HDI and others) accounting for 476 (12.0%) of the WRA case exposures. Metal working fluids (coolants) accounted for 335 (8.5%) of Michigan worker exposures.

There is ongoing interest in ingredients in cleaning products that can cause new-onset asthma and aggravate existing asthma. These products, used both in the home and in all industry sectors can contain disinfectants, often quaternary amines, which have been repeatedly shown to cause asthma among workers who either use them or are in the area when they are being used. The Michigan WRA Tracking Program has developed a brochure on the hazards of cleaning agents. It is available at www.oem.msu.edu and can be found under the **Resources Section.**

Welding is the fifth most common cause of WRA in Michigan (not including unknown manufacturing and unknown office exposures). Both welders themselves as well as individuals who work in the same area may be affected by welding fume. A previous publication highlighted the morbidity and high health care costs from asthma associated with welding[3].

**TOP EXPOSURES OVER TIME:** Table 10 shows the trends among the top exposures by time period. Isocyanates decreased from 19.9% of all the WRA exposures in 1988-1997 to 6.6% in 2018-2022. Cleaning agents increased from 4.6% of all the WRA exposures in 1988-1997 to 21.0% in 2018-2022. Metalworking fluids, solvents, latex rubber, welding fume, formaldehyde and acids also decreased over time, while there was an increase in cases reported from exposure to epoxy, fungus and paint fumes over time.

Figure 3 represents another way to look at exposures over time. It shows the number of individuals with work-related asthma by type of exposure from 1988-2022. Trends are shown for the five most common causes of WRA and all other exposures that could be grouped as either low molecular weight (i.e., chemicals, metals) or high molecular weight (i.e., organic material, plant or animal) agents. The data is grouped into 2-year time categories to give more stability to smaller numbers of cases in a single year. The number of individuals with WRA caused by metal-working fluids and other chemicals with low molecular weights appears to be trending downward although diisocyanates showed a slight increase after 2011. Office, and animal or plant products with high molecular weights appear unchanged. Cleaning agents appear to be trending upward until 2006-2007 and then decreasing since that time. The manufacturing industry and associated exposures have been decreasing over time.

**EMERGING EXPOSURES:** In Michigan, medical marijuana became legal in 2008 and recreational marijuana in 2018. With legalization came the opening of multiple facilities that grow and process marijuana. There are over 700 licensed growing facilities, 135 licensed processing facilities and over 305 licensed provisioning facilities. There are over 30,000 workers in the industry. Workers in the marijuana industry may be exposed to several asthma-causing agents: marijuana plant dust, off-gassing of terpenes during the marijuana plant drying process, disinfectants, *i.e.* bleach and hydrogen peroxide/peracetic acid and mold, *i.e. Alternaria* and *Penicillium*. Five cases of WRA have been reported among marijuana industry workers in Michigan. An additional six patients have been reported with acute bronchitis, pneumonitis and other respiratory symptoms from Michigan grow facilities: two workers from one incident after bleach and a cleaner with acid were mixed and generated chlorine gas, two workers from one incident after grinding used containers of fungicides and herbicides, and one worker each from exposure to ozone and a sanitizer containing 75% ethanol. Respiratory irritant exposures in marijuana grow facilities include ozone, cleaning agents, fungicides, herbicides, and insecticides (https://oem.msu.edu/images/newsletter/Fall2023Vol34n4newsletter.pdf).

## TABLE 9
## Workplace Exposures Associated with Confirmed WRA Patients: 1988-2022

| Exposure Agent | # | % |
|---|---|---|
| Cleaning Solutions | 532 | 13.5 |
| Isocyanates | 476 | 12.0 |
| Metal Working Fluids | 335 | 8.5 |
| Unknown (Mfg.) | 297 | 7.5 |
| Unknown (Office) | 211 | 5.3 |
| Exhaust/Smoke/Fumes | 180 | 4.6 |
| Welding Fume-Stainless & Other | 165 | 4.2 |
| Solvents | 111 | 2.8 |
| Paint Fumes | 97 | 2.5 |
| Fungus | 95 | 2.4 |
| Epoxy | 92 | 2.3 |
| Acids | 73 | 1.8 |
| Fire | 73 | 1.8 |
| Formaldehyde | 66 | 1.7 |
| Latex/Rubber | 63 | 1.6 |
| Construction Exposures | 59 | 1.5 |
| Plastic Fumes | 57 | 1.4 |
| Chlorine | 55 | 1.4 |
| Animal Dander | 50 | 1.3 |
| Fragrances | 40 | 1.0 |
| Acrylates | 38 | 1.0 |
| Cobalt | 34 | 0.9 |
| Wood Dust | 33 | 0.8 |
| Flour | 29 | 0.7 |
| Ammonia | 26 | 0.7 |
| Herbicide/Pesticide | 22 | 0.6 |
| Cigarette Smoke | 21 | 0.5 |
| Styrene | 20 | 0.5 |
| Fiberglass | 20 | 0.5 |
| Plants/Organic Matter | 19 | 0.5 |
| Aldehydes | 18 | 0.5 |
| Medication | 18 | 0.5 |
| Cement Dust | 16 | 0.4 |
| Chromium | 16 | 0.4 |
| Heat | 15 | 0.4 |
| Amines | 14 | 0.4 |
| Cosmetology Chemicals | 14 | 0.4 |
| Asphalt | 14 | 0.4 |
| Caustics | 14 | 0.4 |
| Fire Extinguisher Powder | 14 | 0.4 |
| Rust Inhibitor | 13 | 0.3 |
| Printing Inks | 13 | 0.3 |
| Grain Dust | 13 | 0.3 |
| Metal Dust | 12 | 0.3 |
| Anhydrides | 11 | 0.3 |
| Sewage | 10 | 0.3 |
| Insecticides | 9 | 0.2 |
| Meat Wrapper's Asthma | 9 | 0.2 |
| Other[a] | 322 | 8.1 |
| **Total** | **3,954** | |

[a]There were 8 cases each with exposure to: Cold Air, Freon and Paper Dust.

There were 7 cases each with exposure to: Azodicarbonamide, Cooking Oil, Enzymes, Pepper Gas, Polyurethane.

There were 6 cases each with exposure to: Drywall Dust, Exertion, Nitrogen, Pickling Ingredients, Solder Fume, Sulfur Dioxide, Textile Lint.

There were 5 cases each with exposure to: 1,1,1 Trichloroethane, Coal Dust, Hydraulic Fluid, Lime Dust, Mold Release Spray, Photo Developing Fluids, Sand.

There were 4 cases each with exposure to: Asbestos, Coal Tar, Copier Toner, Natural Gas, Rose Hips, Sulfonate, Trichloroethylene, X-Ray Developing Fluids

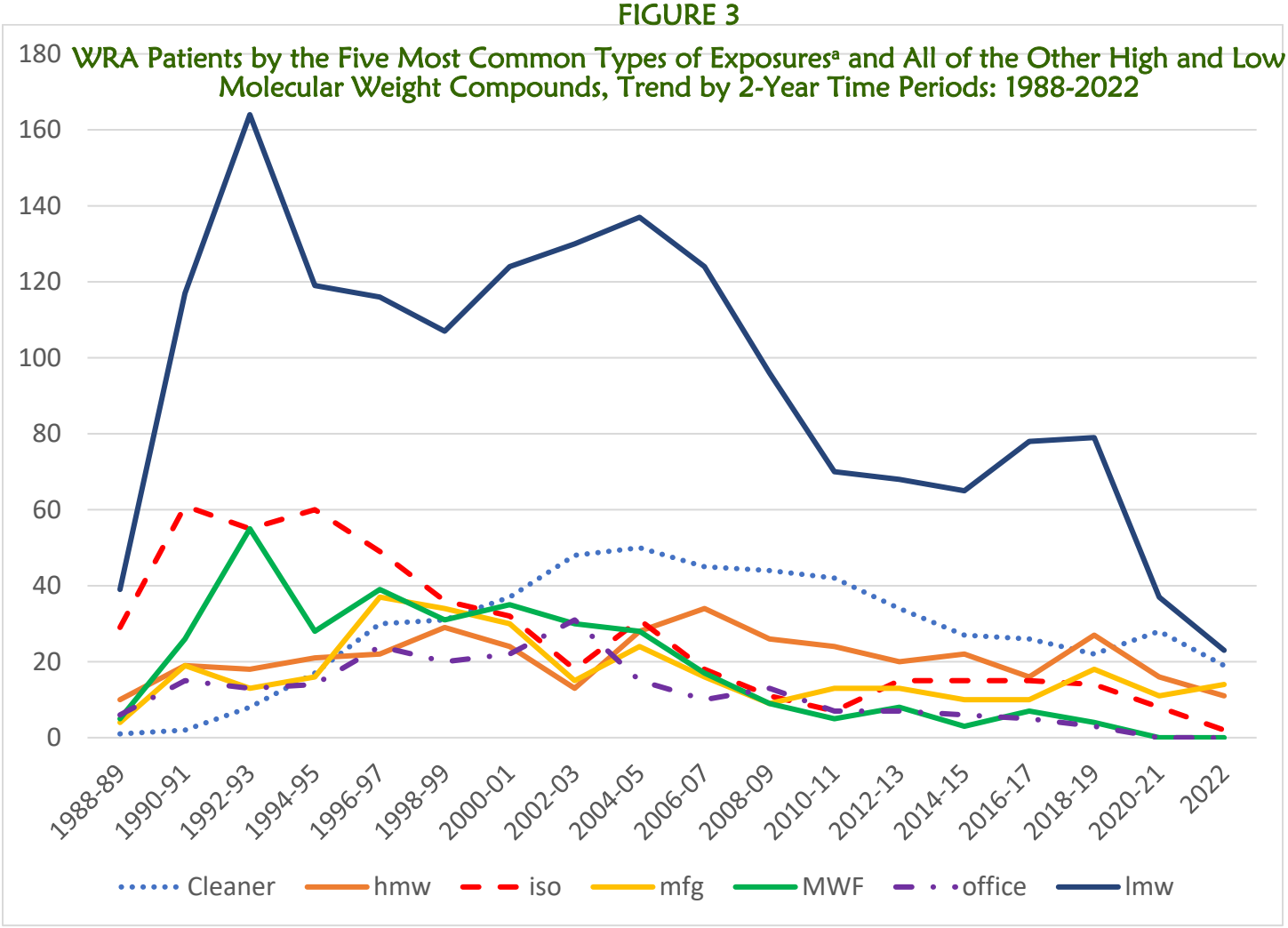
There were 3 cases each with exposure to: Cadmium Solder, Colophony, COVID-19, Explosion, Fertilizer, Flux, Kerosene, Nickel, Ozone, Polyethylene, Sludge, Zinc, Zinc Oxide.

There were 2 cases each with exposure to: Barbeque Smoker, Bitrex, Calcium Chloride (used in Cherry Brine), Car Window Sealant, Carbon Dioxide, Cellulose, Concrete Sealer, Copper Oxide, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Glaze, Heated Polyvinyl Chloride, Isopropyl Alcohol, Methamphetamine Lab, Odor, Perchloroethylene, Phosgene, Plating Chemicals, Polyester, Polyvinyl Butyrate, Silicone, Sulfite, Talcum Powder, Teflon, Vinyl Acetate Acrylic, Wastewater Treatment Chemicals.

There was 1 case each with exposure to: 1,3,Dichloro-2-Propanol, 1-bromo-3-chloro-5 5-Dimethyl Hydantoin, Agent Orange, Ammonium Bifluoride, Ammonium Chloride, Antifreeze, Auto Body Shop Chemicals, Benzoate Esters, Blood, Blue Prints, Calcium Carbonate, Carbon Monoxide, Catheter Demonstration Chemical, Ceramic Powder, Cereal Dust from Food Manufacturing, Crude Oil, Cyanide, Deck Stain, Desert Storm, Dry Ice, Eggs, Ethylene Oxide, Face Mask, Flares, Gortex, Greenhouse Chemicals, Hydrogen Gas, Iodine, Laboratory Chemicals, Metal Finishing Chemicals, Methane, Methanol, Mica, Monoammonium Phosphate, Ninhydrin, Nonylphenol Polyethylene Glycol Ether, Nylon-polyhexamethylene Adipamide, Phenol, Pigment, Phosphate, Plasma Cutting, Platinum, Polyolefin, Potassium Aluminum Fluoride, Polybutadiene, Propane, Smoke from Burning Food, Soda Ash, Sodium Acetate, Sodium Chlorite, Soot, Spices, Stress, Swimming Pool Shock, Tetrahydrofuran, Titanium Tetrachloride, Tuberculosis Vaccine, Vaping Fumes, Vinegar, White Lithium, Wood Smoke, World Trade Center Exposure, Zinc Borate.

| TABLE 10<br>Top Workplace Exposures of WRA Patients by Time Period | | | | | | |
|---|---|---|---|---|---|---|
| | | Time Period | | | | |
| | All Years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | Change in Percentage |
| **Exposure Type** | # (%) | # (%) | # (%) | # (%) | # (%) | |
| Cleaning Agents | 532 (13.5) | 59 (4.6) | 214 (14.6) | 183 (21.4) | 76 (21.0) | + 357% |
| Isocyanates | 476 (12.0) | 253 (19.9) | 136 (9.3) | 63 (7.4) | 24 (6.6) | - 67% |
| Metalworking Fluids | 335 (8.5) | 153 (12.0) | 144 (9.9) | 32 (3.7) | 6 (1.7) | - 86% |
| Welding Fume | 165 (4.2) | 62 (4.9) | 62 (4.2) | 31 (3.6) | 10 (2.8) | - 43% |
| Solvents | 111 (2.8) | 50 (3.9) | 49 (3.4) | 9 (1.1) | 3 (0.8) | - 79% |
| Paint | 97 (2.5) | 18 (1.4) | 49 (3.4) | 21 (2.5) | 9 (2.5) | + 79% |
| Epoxy | 92 (2.3) | 33 (2.6) | 27 (1.8) | 19 (2.2) | 13 (3.6) | + 38% |
| Fungus | 95 (2.4) | 0 | 41 (2.8) | 38 (4.4) | 16 (4.4) | + 57% |
| Formaldehyde | 66 (1.7) | 33 (2.6) | 17 (1.2) | 15 (1.8) | 1 (0.3) | - 88% |
| Acids | 73 (1.8) | 27 (2.1) | 24 (1.6) | 15 (1.8) | 7 (1.9) | - 10% |
| Latex/Rubber | 63 (1.6) | 25 (2.0) | 32 (2.2) | 4 (0.5) | 2 (0.6) | - 70% |

FIGURE 3




[a]Cleaner=cleaning agents, hmw=high molecular weight agents, iso=diisocyanates, mfg=manufacturing agents, MWF=metal working fluids, office=office exposures, lmw=low molecular weight agents.

# *Medical Results – Trends*

**SMOKING STATUS** Table 11 shows patients' cigarette smoking status. Slightly less than 20% of patients were smoking when their asthma developed.

**SMOKING STATUS OVER TIME** Table 12 shows the change in cigarette smoking status over time. There was an increase in the percentage of WRA patients who never smoked over time, corresponding with decreases among those who ever or currently smoked cigarettes. The percentage of current smokers in the most recent time period is slightly higher than the state average for 2022 (15.2%) (Michigan.gov/BRFS).

**ALLERGIES AND ASTHMA** Forty-five percent of WRA patients had a family history of allergies (data not shown). Seventeen percent of the asthma patients had a personal history of allergies and asthma (Table 13). Forty-three percent had no history of allergies or asthma.

**HEALTH CARE USAGE** Sixty-seven percent of the WRA patients had at least one visit to the Emergency Department (ED) in their lifetime for their WRA, and 34% had at least one hospitalization for their WRA (Table 14). The average number of ED visits was 5.2 and the average number of hospitalizations was 3.6.

**WORK-RELATED ASTHMA DEATHS** Fortunately, a very small percent (0.01-0.02%) of asthma patients die from asthma. From 2003 to 2008, we have identified eight work-related asthma deaths.

There were two WRA deaths in 2022: a 31-year-old male who had just begun working at a cereal manufacturer died from exposure to cereal dust, and a 52-year-old male who worked for a plastic injection molding company died from exposure to welding fume. There were no WRA deaths reported in 2020 or 2021. There was one WRA death in 2019: a waiter with a known fish allergy died when the regular cook was off, and the replacement cook was not aware of the procedures used to minimize the waiters' exposure to fish. There were no work-related asthma deaths identified in calendar years 2009 through 2012, 2014, or 2016-2018. There was one work-related asthma death each in 2013 and 2015. We have published articles on some of the work-related asthma deaths[4,5].

**TABLE 11**
**Cigarette Smoking Status of 3,788[a]**
**Confirmed WRA Patients: 1988-2022**

| | Smoking Status | | | | | | |
|---|---|---|---|---|---|---|---|
| | Current | | Ex-Smoker | | Non-Smoker | | TOTAL |
| | # | % | # | % | # | % | |
| OA | 253 | 20.7 | 465 | 38.0 | 507 | 41.4 | 1,225 |
| POA | 201 | 15.2 | 531 | 40.1 | 591 | 44.7 | 1,323 |
| AA | 170 | 20.5 | 205 | 24.8 | 453 | 54.7 | 828 |
| RADS | 111 | 26.9 | 154 | 37.4 | 147 | 35.7 | 412 |
| All | 735 | 19.4 | 1,355 | 35.8 | 1,698 | 44.8 | 3,788 |

[a]Missing data on 166 patients.

**The percentage of Michigan adult smokers has varied over time, from a high of 27.4% in 1998, to a low of 20.5% in 2010, an increase in 2011 to 23.3%, a decrease to 17% in 2021 and a decrease to 15.2% in 2022.**

**TABLE 12**
**Cigarette Smoking Status of WRA Patients by Time Period**

| | | Time Period | | | | |
|---|---|---|---|---|---|---|
| | All Years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | Change in Percentage |
| **Smoking Status** | # (%) | # (%) | # (%) | # (%) | # (%) | |
| Current | 735 (19) | 243 (20) | 295 (21) | 140 (17) | 57 (17) | - 15% |
| Ex-Smoker | 1,355 (36) | 540 (43) | 479 (34) | 258 (32) | 78 (24) | - 44% |
| Non-Smoker | 1,698 (45) | 463 (37) | 632 (45) | 409 (51) | 194 (59) | + 59% |
| Total | 3,788[a] | 1,246 | 1,406 | 807 | 329 | |

[a]Missing data on 166 patients.

## TABLE 13
## Personal History of Allergies or Asthma Among 3,579[a] Confirmed WRA Patients: 1988-2022

Personal History of...

| | Allergies & Asthma | | Asthma Only | | Allergies Only | | No Allergies or Asthma | |
|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % |
| OA | 70 | 6.1 | 61 | 5.3 | 345 | 29.9 | 678 | 58.8 |
| POA | 94 | 7.7 | 65 | 5.3 | 421 | 34.3 | 646 | 52.7 |
| AA | 419 | 49.5 | 386 | 45.6 | 22 | 2.6 | 20 | 2.4 |
| RADS | 17 | 4.8 | 38 | 10.8 | 86 | 24.4 | 211 | 59.9 |
| All | 600 | 16.8 | 550 | 15.4 | 874 | 24.4 | 1,555 | 43.4 |

[a]Missing data on 375 patients.

## TABLE 14
## Health Care Usage Among Confirmed WRA Patients: 1988-20221

Lifetime History of Health Care Usage

| ED Visit[a] | | Hospitalized[b] | |
|---|---|---|---|
| Yes # (%) | No # (%) | Yes # (%) | No # (%) |
| 2,488 (67) | 1,228 (33) | 1,188 (34) | 2,304 (66) |
| Range 1-300 visits | | Range 1-200 hospitalizations | |
| AVG 5.2 ±14.3 | | AVG 3.6±9.7 | |

[a]Missing data on 238 patients.
[b]Missing data on 462 patients.

### SYMPTOMS

Three thousand fifteen (3,015) of the patients with WRA had persistence of their asthma symptoms (Table 15). Higher percentages of those *still exposed* continued to have breathing problems and take asthma medicine compared to those *no longer exposed*. Higher percentages of those *no longer exposed* had improved breathing and were taking less medicine.

**SYMPTOMS OVER TIME:** Sixty-seven to 72% of the cases were no longer exposed to the agent associated with their WRA. Among those still exposed to the agent associated with their WRA, there was a trend of less symptom improvement for those still experiencing breathing problems (Table 16). During 1988-1997, 34% of those still exposed with breathing problems still present, reported their symptoms were improving, compared to 50% among those no longer exposed; during 2018-2022, 17% of those still exposed reported an improvement in symptoms, compared to 30% among those no longer exposed. Also, among those still exposed, there was a decrease among those reporting the need for less asthma medication, with 21% reporting the need for less asthma medication during 1988-1997 compared to 30% among those no longer exposed, and 7% reporting the need for less asthma medication during 2018-2022, compared to 22% among those no longer exposed.

## TABLE 15
## Persistence of Symptoms and Medication Use in 3,482 Confirmed WRA Patients: 1988-2022

| Still Exposed? | Total | Breathing Problems Still Present? | | | | Still Taking Asthma Medications? | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Yes | | Less | | Yes | | Less | |
| | | # | % | # | % | # | % | # | % |
| Yes | 1,019 | 969 | 95.1 | 290 | 28.5 | 890 | 87.3 | 172 | 16.9 |
| No | 2,463 | 2,046 | 83.1 | 1,144 | 46.4 | 1,921 | 78.0 | 702 | 28.5 |
| Total | 3,482[a] | 3,015 | | 1,434 | | 2,811 | | 874 | |

[a]Information missing on 472 individuals.

**Individuals with work-related asthma are often exposed to low levels of a sensitizer for a long period of time before their breathing problems develop.**

# *Medical Results – Trends, continued…*

## TABLE 16
### Persistence of Symptoms and Medication Use in Confirmed WRA Patients by Time Period

| Time Period | Still Exposed? | Total | Breathing Problems Still Present? | | | | Still Taking Asthma Medications? | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yes # | Yes % | Less # | Less % | Yes # | Yes % | Less # | Less % |
| 1988-1997 | Yes | 339 | 326 | 96.2 | 116 | 34.2 | 288 | 85.0 | 72 | 21.2 |
| | No | 852 | 705 | 82.7 | 422 | 49.5 | 633 | 74.3 | 251 | 29.5 |
| | Total | 1191 | 1031 | | 538 | | 921 | | 323 | |
| 1998-2007 | Yes | 389 | 376 | 96.7 | 109 | 28.0 | 336 | 86.4 | 64 | 16.5 |
| | No | 923 | 828 | 89.7 | 432 | 46.8 | 760 | 82.3 | 246 | 26.7 |
| | Total | 1312 | 1204 | | 541 | | 1096 | | 310 | |
| 2008-2017 | Yes | 210 | 194 | 92.4 | 51 | 24.3 | 193 | 91.9 | 30 | 14.3 |
| | No | 527 | 397 | 75.3 | 241 | 45.7 | 410 | 77.8 | 169 | 32.1 |
| | Total | 737 | 591 | | 292 | | 603 | | 199 | |
| 2018-2022 | Yes | 81 | 73 | 90.1 | 14 | 17.3 | 73 | 90.1 | 6 | 7.4 |
| | No | 161 | 116 | 72.0 | 49 | 30.4 | 118 | 73.3 | 36 | 22.4 |
| | Total | 242 | 189 | | 63 | | 191 | | 42 | |
| Change in Percentage | Yes | | | -6% | | -49% | | +6% | | -65% |
| | No | | | -13% | | -39% | | -1% | | -24% |

**PULMONARY FUNCTION TESTING**

The percentage of WRA patients who had different types of pulmonary function testing overall and by time period is listed below (Table 17). There was a decrease in the percentage of patients who had pre-post bronchodilatation and a methacholine challenge test over time. Too few individuals had peak flow monitoring at work and home, pre-post work-shift testing or specific antigen challenge testing to calculate changes over time.

## TABLE 17
### Pulmonary Function Testing of WRA Patients by Time Period

| | | Time Period | | | | |
|---|---|---|---|---|---|---|
| | All Years | 1988-1997 | 1998-2007 | 2008-2017 | 2018-2022 | Change in Percentage |
| **Test Type** | (%) | (%) | (%) | (%) | % | |
| Pre-post Bronchodilatation | 49 | 54 | 54 | 44 | 16 | - 70% |
| Methacholine Challenge | 17 | 25 | 16 | 10 | 3 | - 88% |
| Peak Flow at Work & Home | 3 | 3 | 3 | 5 | 2 | [a] |
| Pre-post Work-shift | 3 | 2 | 4 | 3 | 1 | [a] |
| Specific Antigen Challenge | <1 | 0.9 | 0.3 | — | -- | [a] |

[a]Not calculated because the number of individuals with testing was too small.

# *Workplace Investigations – Trends*

## WORKERS' COMPENSATION

Over all the years of reports, 49% of individuals with work-related asthma applied for workers' compensation benefits; among those, 40% were awarded, 17% were denied and 43% were pending approval at the time they were interviewed.

**WORKERS' COMPENSATION OVER TIME:** The percentage of WRA patients who applied for workers' compensation benefits did not change across the time periods: 1988-1997, 1998-2007, 2008-2017 and 2018-2022. The first two time periods showed 49% of patients applying for workers' compensation benefits, and the third and fourth periods each had 50% apply. However, there were differences in the outcomes of applying for benefits, with an increase in the percentage awarded benefits over the three time periods from 37% to 33% to 47% to 66% in the most recent time period. The percentage of claims denied increased over the first three time periods, from 16% to 17% to 22%, and decreased to 15% in the most recent time period. Accordingly, the percentage of claims pending approval decreased from 48% to 50% to 32% to 18% in the most recent time period.

## INDUSTRIAL HYGIENE

A total of 823 workplace inspections have been conducted since 1988 (Table 18); 123 of those facilities have been inspected more than once. There was one inspection in 2020, one inspection in 2021 and two inspections in 2022.

Air sampling was conducted during 587 inspections (Table 19); 31 of the 582 (5.3%) facilities *with a MIOSHA standard for the presumed causal agent* were above the enforceable permissible exposure limit.

### TABLE 18
### Status of Facilities Where Confirmed WRA Patients Were Exposed to the Suspected Causal Agent: 1988-2022

| | # Patients | Companies | |
|---|---|---|---|
| Inspection Status | Represented | # | % |
| Inspected | 1,291 | 823[a] | 28.8 |
| No Follow-up Planned | 2,454 | 1,845 | 64.5 |
| Scheduled for Inspection | 0 | 0 | -- |
| Out of Business | 79 | 71 | 2.5 |
| No Longer Use Occupational Allergen | 27 | 26[b] | 0.9 |
| Sent Company Letter to Check Exposures[d] | 103 | 96 | 3.4 |
| Total | 3,954 | 2,861[c] | |

[a]823 inspections were conducted in 700 different workplaces.
[b]Eight companies that no longer use the suspected causal agent were previously inspected.
[c]Represents 2,738 different facilities.
[d]The company was sent information on how to address potential exposures including indoor air issues in their workplace that may be causing respiratory health problems.

**It is difficult to track illness among temporary workers, due to the transient nature of their work and the ambiguity of responsibility for reporting their occupational illnesses.**

# *Workplace Investigations – Trends*

## TABLE 19
## Air Monitoring Results from 823 Workplace Inspections: 1988-2022

| Air Sampling – NIOSH Standard | # | % |
|---|---|---|
| Above NIOSH Standard | 67 | 8.1 |
| Below NIOSH Standard | 490 | 59.5 |
| No NIOSH Standard | 33 | 4.0 |
| Unknown (no report yet) | 5 | 0.6 |
| Did Not Sample for an Allergen | 30 | 3.6 |
| Did Not Sample | 198 | 24.1 |
| Total | 823 | |
| | | |
| Air Sampling – MIOSHA Standard | # | % |
| Above MIOSHA Standard | 31 | 3.8 |
| Below MIOSHA Standard | 551 | 67.0 |
| No MIOSHA Standard | 7 | 0.9 |
| Unknown (no report yet) | 5 | 0.6 |
| Did Not Sample for an Allergen | 31 | 3.8 |
| Did Not Sample | 198 | 24.1 |
| Total | 823 | |

### AIR MONITORING

Table 20 shows the suspected causal agents that were above the NIOSH and/or MIOSHA limits. The top four allergens found to be above the NIOSH REL were:

- Formaldehyde
- Cobalt
- Styrene
- Metal Working Fluids

The top four suspected causal agents found to be above the MIOSHA enforceable PEL were:

- Welding Fume
- Cobalt
- Styrene
- Glutaraldehyde

**Workers exposed to asthma-causing agents BELOW permissible limits are developing work-related asthma.**

## TABLE 20
## Suspected Causal Agents Above the MIOSHA Permissible Exposure Limit (PEL) and/or NIOSH Recommended Exposure Limit (REL): Michigan 1988-2022

| | Above NIOSH REL | | Above MIOSHA PEL | |
|---|---|---|---|---|
| Asthma-Causing Agents | # | % | # | % |
| Formaldehyde | 28 | 41.8 | 1 | 3.2 |
| Cobalt | 8 | 11.9 | 6 | 19.4 |
| Styrene | 6 | 9.0 | 4 | 12.9 |
| Metal-Working Fluids | 5 | 7.5 | 1 | 3.2 |
| Glutaraldehyde | 4 | 6.0 | 3 | 9.7 |
| HDI | 4 | 6.0 | No PEL | -- |
| MDI | 3 | 4.5 | 0 | -- |
| Wood Dust | 3 | 4.5 | 2 | 6.5 |
| Chromic Acid | 1 | 1.5 | 1 | 3.2 |
| Ethylene Oxide | 1 | 1.5 | 0 | -- |
| Phthalic Anhydride | 1 | 1.5 | 1 | 3.2 |
| Starch | 1 | 1.5 | 0 | -- |
| Total Dust (Dry Plant Materials) | 1 | 1.5 | 0 | -- |
| Total Dust (Grinding on Fiberglass) | 1 | 1.5 | 1 | 3.2 |
| Welding Fume (Total Particulate) | No REL | -- | 9 | 29.0 |
| Flour Dust | No REL | -- | 2 | 6.5 |
| TOTAL | 67 | | 31 | |

# *Co-Worker Interviews at Workplace Investigations – Trends*

Co-workers were interviewed during 624 of the 823 inspections. Workers had daily or weekly breathing symptoms associated with work or new-onset asthma since beginning to work at 403 of the 624 (65%) companies. The average percentage of co-workers with symptoms in these 403 companies was 20.4%. All 1,708 co-workers from the remaining 221 companies reported no daily or weekly breathing symptoms associated with work. One thousand six hundred thirty-five (1,635) of the 10,565 (15.5%) co-workers interviewed had symptoms consistent with work-related asthma (Table 21). Over time, the percentage of co-workers with breathing problems decreased between the first two periods, but then increased during the third period and decreased in the fourth period.

The MIOSHA Injury and Illness Logs (Form 300) kept by employers listed 586 workers from 137 companies with asthma or asthma-like symptoms. Only 10 workers identified in the interviews with daily or weekly chest tightness, shortness of breath (SOB) or wheezing were also listed on the MIOSHA Log. Combining the information from the interviews and Injury and Illness Logs, a total of 2,221 symptomatic workers were identified during the 823 MIOSHA enforcement inspections.

**TABLE 21**
**Daily or Weekly Breathing Symptoms at Work or New-Onset Asthma Among Co-Workers of the 3,954 Confirmed WRA Patients: 1988-2022 and by Time Period**

| | # Companies Inspected where Co-Workers were Interviewed | # Co-Workers with Daily or Weekly Breathing Symptoms at Work or New-Onset Asthma/# Co-Workers Interviewed | % |
|---|---|---|---|
| | 624 | 1,635/10,565 | 15.5 |
| **BY TIME PERIOD:** | | | |
| **1988-1997** | 339 | 1,125/6,293 | 17.9 |
| **1998-2007** | 204 | 380/3,200 | 11.9 |
| **2008-2017** | 75 | 121/979 | 12.4 |
| **2018-2022** | 6 | 9/93 | 9.7 |
| | | | |
| | | | |
| | # Companies with >=1 Co-Worker on OSHA Log with Asthma or Asthma Symptoms/# Companies Inspected | # Co-Workers on OSHA Log with Breathing Symptoms | |
| | 137/823 | 586 | |
| **BY TIME PERIOD:** | | | |
| **1988-1997** | 76/437 | 400 | |
| **1998-2007** | 52/266 | 174 | |
| **2008-2017** | 8/108 | 11 | |
| **2018-2022** | 1/12 | 1 | |
| Total Co-Workers with Symptoms from Interviews and OSHA Logs | | 2,221 | |

[a]Ten individuals were identified on both the co-worker questionnaire and the OSHA Log.

**The sooner an individual with WRA is diagnosed and removed from the agent associated with their asthma, the better the prognosis for improvement in symptoms.**

# *Michigan Workforce Exposed to Select Causes of WRA*

The United States Environmental Protection Agency (EPA) requires reporting by manufacturers, mines or electrical utilities that have at least 10 employees and use any one of 650 different chemicals in amounts greater than 10,000 pounds per year. Queries of reportable chemicals can be generated to identify state-level statistics. We identified Michigan's isocyanate-using companies in the EPA Toxic Release Inventory (TRI) to estimate the number of workers employed by manufacturers potentially exposed to isocyanates, one of the most commonly reported causes of WRA in Michigan (Table 22). Our estimate undercounts non-manufacturing exposed employees such as at auto body paint shops because the EPA does not include non-manufacturing establishments. Conversely, our estimate overcounts manufacturing employees because we included the total number of employees at each facility that reported isocyanates, even though not all workers at these facilities would have worked with or around isocyanates.

Another possible source to identify chemical exposures associated with WRA is the Michigan Department of Environment, Great Lakes, and Energy (EGLE, formerly the Department of Environmental Quality (DEQ)). The chemicals listed in the Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting (December 2007, 6th edition) are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313, triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at Michigan facilities. Unlike the EPA TRI data, all companies must report if they meet the threshold amount of chemical used; there are no limitations to reporting based on the type of facility or the number of individuals employed. ***As of 2021, overall EGLE data is no longer available due to a change in their FOIA procedures. Individuals, including community residents, health care providers, safety professionals and workers, can request individual company information on chemicals reported to EGLE.***

In the EPA TRI, 84 companies reported using isocyanates in 2022; there were 79 companies in 2021, 95 companies in 2020, 104 companies in 2019, 106 companies in 2018, 112 companies in 2017, 111 companies in 2016 and 112 companies in 2015. The number of workers employed in companies that use isocyanates, the total number of workers in these counties, and the percentage of workers by county who work in facilities where isocyanates are used are listed in Table 22. In 2022, there were 22,403 workers potentially exposed to isocyanates in manufacturing, which is an approximate decrease of 1600 workers compared with 24,020 workers in 2021. There were 29,894 workers in 2020 and 45,298 workers in 2019 potentially exposed to isocyanates.

**TABLE 22 Michigan Workers Employed in Manufacturing Facilities in 2022 Where Isocyanates are Used, by County**

| County | Company Name[a] | # Workers Employed by Isocyanate Using Facilities[b] | Total # Workers in the County[c] | % Workers Potentially Exposed to Isocyanates |
|---|---|---|---|---|
| **ALLEGAN** | MOTUS INTEGRATED TECHNOLOGIES—MAPLEWOOD<br>YAN FENG AUTOMOTIVE INTERIORS PMSC | 277 | 59,858 | **0.5** |
| **BARRY** | BRADFORD WHITE CORP | 900 | 30,825 | **2.9** |
| **BAY** | QUANTUM COMPOSITES INC | 14 | 46,493 | **<0.1** |
| **BERRIEN** | LECO CORP<br>NCP COATINGS<br>NILES STEEL TANK | 642 | 68,758 | **0.9** |
| **BRANCH** | GOKOH COLDWATER INC | 15 | 18,912 | **0.1** |
| **CALHOUN** | BREMBO HOMER FOUNDRY<br>COMCAST URETHANE<br>TRANSCONTINENTAL | 98 | 57,498 | **0.2** |
| **CLARE** | LEAR CORP. FARWELL PLANT | 278 | 10,648 | **2.6** |

| Table 22. County | Company Name[a] | # Workers Employed by Isocyanate Using Facilities[b] | Total # Workers in the County[c] | % Workers Potentially Exposed to Isocyanates |
|---|---|---|---|---|
| **CRAWFORD** | WEYERHAEUSER | 59 | 5,127 | **1.2** |
| **DICKINSON** | GREDE, LLC IRON MOUNTAIN<br>LOUISIANA-PACIFIC-SAGOLA OSB | 685 | 11,737 | **5.8** |
| **EATON** | ALLIANCE INTERIORSSIKAAXON US | 50 | 53,741 | **0.1** |
| **HILLSDALE** | ESSEX SPECIALTY PRODUCTS | 2 | 19,223 | **<0.1** |
| **HURON** | VALLEY ENTERPRISES | 121 | 14,303 | **0.8** |
| **INGHAM** | HUNTSMAN ADVANCED MATERIALS<br>SA AUTOMOTIVE | 223 | 140,394 | **0.2** |
| **ISABELLA** | THE DELFIELD CO.<br>UNIFIED BRANDS | 1,049 | 30,860 | **3.4** |
| **JACKSON** | MILSCO MICHIGAN SEAT<br>TAC MFG | 377 | 70,758 | **0.5** |
| **KALAMAZOO** | AZON USA<br>FLOWSERVE CORP<br>STRYKER INSTRUMENTS | 1,204 | 127,053 | **0.9** |
| **KENT** | FLEXIBLE STEEL LACING CO, DBA FLEXCO<br>GRAND RAPIDS FOAM TECHNOLOGIES<br>HB FULLER<br>KENDRICK PLASTICS<br>LACKS WHEEL TRIM SYSTEMS, BARDEN PLATER<br>NORDIC SPAS LLC<br>PURFORMS INC.<br>RICHWOOD INDUSTRIES INC. | 1,040 | 350,035 | **0.3** |
| **LENAWEE** | ANDERSON DEVELOPMENT<br>INTEVA PRODUCTS | 415 | 43,133 | **1.0** |
| **LIVINGSTON** | ANTOLIN-HOWELL | 718 | 100,456 | **0.7** |
| **LUCE** | LOUISIANA-PACIFIC CORP-NEWBERRY SIDING | 14 | 2,013 | **0.7** |
| **MACOMB** | AXALTA COATING SYSTEMS<br>FCA US ASSEMBLY PLANT<br>INTERNATIONAL CASTING CORP<br>L & L PRODUCTS INC.<br>MAYCO INTERNATIONAL<br>ROMEO RIM INC<br>SHELBY FOAM SYSTEM<br>WOLVERINE BRONZE | 2,263 | 426,693 | **0.5** |
| **MASON** | GREAT LAKES CASTING | 210 | 12,543 | **1.7** |
| **MIDLAND** | DDP SPECIALTY ELECTRONIC PARTS LLC | 349 | 38,455 | **0.9** |
| **MONROE** | SUNRISE WINDOWS LTD | 452 | 71,499 | **0.6** |
| **MONTCALM** | KENT FOUNDRY<br>MARVEL REFRIGERATION | 84 | 26,742 | **0.3** |
| **MUSKEGON** | MUSKEGON COMPOSITES, INC<br>STRUCTURAL CONCEPTS-PLANT 2 | 489 | 73,242 | **0.7** |
| **OAKLAND** | ARMALY SPONGE<br>EAGLE INDUSTRIES<br>LYMTAL INTERNATIONAL INC<br>TEMPERFORM CORP.<br>WEBASTO ROOF SYSTEMS | 409 | 648,819 | **0.1** |
| **OGEMAW** | TAYLOR ENTRANCE SYSTEMS<br>WAUSAU SUPPLY CO. | 181 | 7,697 | **2.4** |

| Table 22. County | Company Name[a] | # Workers Employed by Isocyanate Using Facilities[b] | Total # Workers in the County[c] | % Workers Potentially Exposed to Isocyanates |
|---|---|---|---|---|
| **OTTAWA** | MAGNA ENGINEERED GLASS<br>ROYAL TECH | 80 | 157,634 | **0.1** |
| **SAGINAW** | GLASTENDER<br>POREX TECHNOLOGIES<br>SAGINAW METAL CASTING OPERATIONS | 905 | 78,542 | **1.2** |
| **SANILAC** | ASCO LP<br>GRUPO ANTOLIN<br>MIDWEST RUBBER CO | 520 | 17,916 | **2.9** |
| **ST CLAIR** | IAC PORT HURON | 109 | 71,872 | **0.2** |
| **ST JOSEPH** | FOREST RIVER INC | 400 | 27,325 | **1.5** |
| **VAN BUREN** | MASTER BUILDERS SOLUTIONS CONST. SYSTEMS<br>SPECIAL-LITE INC | 250 | 32,605 | **0.8** |
| **WASHTENAW** | FAURECIA INTERIOR SYSTEMS-SALINE | 1,510 | 188,405 | **0.8** |
| **WAYNE** | BASF CORP—LIVONIA PLANT<br>BASF CORP—WYANDOTTE PLANT<br>CYGNET AUTOMATED CLEANING<br>EQ DETROIT<br>FCA US JEFFERSON NORTH ASSEMBLY PLANT<br>NORTHFIELD MFG.<br>PLASTOMER<br>WINDSOR MACHINE & STAMPING (US) LTD | 5,531 | 757,497 | **0.7** |
| **WEXFORD** | REC BOAT HOLDINGS-CRUISER PLANT<br>REC BOAT HOLDINGS-SPORT/ENGINEERING | 480 | 14,183 | **3.4** |
| **TOTAL** | | **22,403** | **4,664,000** | **0.5** |

[a]Source: U.S. Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2022, data accessed 10/30/2023.

[b]Source: Manta.com and D&B Hoovers accessed 6/3/2024.

[c]Source: Michigan Labor Market Information, Data Explorer, 2022 Annual Employment by County, www.milmi.org accessed 6/3/2024.

Table 23 summarizes any company with one of the 400 TRI-covered 6-digit NAICS codes in the state, by county, that uses other chemicals that are known to cause asthma and those that are irritants and capable of causing Reactive Airways Dysfunction Syndrome. Those that can cause asthma are: Bisphenol A, Cobalt, Epichlorohydrin, Formaldehyde, Methyl Acrylate, Methyl Methacrylate, Phthalic and Maleic Anhydride and Styrene. Ammonia and Chlorine are classified as irritants. These companies were identified through the US EPA TRI for the calendar year 2022. A listing of the 400 TRI-covered 6-digit NAICS codes can be found at: https://guideme.epa.gov/ords/guideme_ext/f?p=guideme:gd:::::gd:naics_codes.

Additional chemical exposures associated with WRA in Michigan can be found in the 2021 report at: oem.msu.edu, under the Resources Section for Work-Related Asthma.

## TABLE 23
## Michigan Facilities by County, Reporting to the United States Environmental Protection Agency (EPA) Toxic Release Inventory (TRI) in 2022[a]

### SUBSTANCES CAPABLE OF CAUSING ASTHMA:
Acrylates, Anhydrides, Bisphenol A, Cobalt, Epichlorohydrin, Formaldehyde & Styrene

### SUBSTANCES CAPABLE OF CAUSING REACTIVE AIRWAYS DYSFUNCTION SYNDROME: Ammonia & Chlorine

A=Ammonia, B=Bisphenol A, CH=Chlorine, CO=Cobalt, E=Epichlorohydrin, F=Formaldehyde, MA=Maleic Anhydride, M=Methyl Acrylate, MMA=Methyl Methacrylate, P=Phthalic Anhydride, S=Styrene

| COUNTY | COMPANY NAME | EXPOSURES |
|---|---|---|
| **ALGER** | NEENAH PAPER MICHIGAN INC. | A |
| **ALLEGAN** | CLARIOS APS PRODUCTION INC. | CO |
| | JBS PLAINWELL | A |
| | LG ENERGY SOLUTION MICHIGAN INC. | CO |
| | SEKISUI KYDEX LLC | S |
| | TIARA YACHTS INC. | S |
| **ALPENA** | DECORATIVE PANELS INTERNATIONAL | F |
| | LAFARGE MIDWEST INC. | A |
| **BARRY** | BRADFORD WHITE CORP. | CO |
| | HASTINGS FIBERGLASS PRODUCTS | S |
| **BAY** | DE KARN JC WEADOCK GENERATING PLANT | A |
| | MERSEN USA GS CORP - BAY CITY | CH |
| | MICHIGAN SUGAR CO - BAY CITY FACTORY. | A |
| | QUANTUM COMPOSITES INC. | MA, S |
| **BERRIEN** | BLUEWATER THERMAL SOLUTIONS | A |
| | NCP COATINGS LLC | CO, P |
| | SPECIAL-LITE INC. | S |
| **BRANCH** | HC STARCK INC. | A, CO |
| | REAL ALLOY RECYCLING LLC | CH |
| | REAL ALLOY SPECIFICATION LLC | CH |
| | STAR OF THE WEST MILLING CO. | CH |
| **CALHOUN** | BASF TODA AMERICA INC. | CO |
| | BLEISTAHL NA LLP | CO |
| | II STANLEY CO INC. | S |
| | KNAUF INSULATION INC. | A |
| | MUSASHI AUTO PARTS-MI INC. | A |
| | ROSLER METAL FINISHING USA LLC | S |
| | THE ANDERSONS MARATHON HOLDINGS LLC - ALBION FACILITY | F |
| | WOODWORTH INC HOMER | A |
| **CASS** | MENNEL MILLING CO. OF MICHIGAN | CH |
| **CHARLEVOIX** | ST MARYS CEMENT U.S. LLC | A |
| **CLINTON** | MWC LLC. | A |
| **CRAWFORD** | ARAUCO NA GRAYLING PARTICLEBOARD | F |
| | BAKELITE CHEMICALS LLC | F |
| | WEYERHAEUSER NR CO. | F |
| **DELTA** | BILLERUD ESCANABA LLC. | CH, F |
| **DICKINSON** | LOUISIANA-PACIFIC SAGOLA OSB | F |

| COUNTY | COMPANY NAME | EXPOSURES |
|---|---|---|
| | BILLERUD QUINNESEC | CH, F |
| **EATON** | ETM ENTERPRISES INC. | S |
| | SIKA ADVANCED RESINS US | S |
| **GENESEE** | WOODWORTH INC FLINT | A |
| **HOUGHTON** | CALUMET ELECTRONICS CORP. | A, F |
| | KOPPERS PERFORMANCE CHEMICALS | A |
| | WARM RAIN CORP. | S |
| **HURON** | CORTEVA AGRISCIENCE LLC - HARBOR BEACH OPERATIONS | A, F |
| | MICHIGAN SUGAR CO - SEBEWAING FACTORY | A |
| | THUMB TOOL & ENGINEERING | A |
| **INGHAM** | AURORA SPECIALTY CHEMISTRIES | E, M |
| | KENT NUTRITION GROUP INC./KENT FEEDS INC. | CO |
| | MOLDED PLASTIC INDUSTRIES INC. | S |
| | NITREX INC. | A |
| | SYMMETRY MEDICAL INC. | CO |
| **IONIA** | BELDING TANK TECHNOLOGIES | S |
| | ROBROY ENCLOSURES | S |
| | THK RHYTHM AUTOMOTIVE | A |
| **JACKSON** | CHEMETALL US INC. | MA |
| | INDUSTRIAL STEEL TREATING | A |
| **KALAMAZOO** | ALLNEX USA INC. | F |
| | HAVILAND PRODUCTS CO. | A, F |
| | PHARMACIA & UPJOHN CO LLC A SUBSIDIARY OF PFIZER INC. | A, CH, E, F |
| **KENT** | ARKEMA INC. | P, S |
| | DFA DAIRY BRANDS FLUID LLC, DBA COUNTRY FRESH | A |
| | GM COMPONENTS HOLDINGS LLC | A |
| | HYDRO-CHEM SYSTEMS | A |
| | KENDRICK PLASTICS | F, S |
| | LACKS TRIM SYSTEMS-AIRLANE | F |
| | LACKS WHEEL TRIM SYSTEMS BARDEN PLATER | F |
| | MICHIGAN TURKEY PRODUCERS LLC-HALL ST SW | A |
| | MICHIGAN TURKEY PRODUCERS-CHICAGO DR SW | A |
| | PLASTIC PLATE INC. - KRAFT PLATER | F |
| | SUPERIOR STONE PRODUCTS INC. | MMA, S |
| **LAPEER** | LAPEER PLATING & PLASTICS INC. | F |
| **LENAWEE** | ADRIAN STEEL CO. | CO |
| | ANDERSON DEVELOPMENT CO. | MA, MMA, S |
| | WACKER CHEMICAL CORP | A |
| **LIVINGSTON** | FORTECH PRODUCTS | A |
| | PROGRESSIVE METAL FORMING INC. | CO |
| | WYMAN-GORDON CO. | CO |
| **LUCE** | LOUISIANA PACIFIC CORPORATION-NEWBERRY | F |
| **MACOMB** | AXALTA COATING SYSTEMS USA LLC-MOUNT CLEMENS PLANT | M, MMA, S |
| | HENKEL US OPERATIONS CORP. | F |
| | INVECAST CORP. | CO |

| COUNTY | COMPANY NAME | EXPOSURES |
|---|---|---|
| | METALLURGICAL PROCESSING CO. | A |
| | SPECIALTY STEEL TREATING INC.. | A |
| **MANISTEE** | PACKAGING CORP OF AMERICA | F |
| **MARQUETTE** | DYNO NOBEL INC | A |
| | EAGLE MINE LLC-HUMBOLDT MILL | CO |
| **MASON** | OCCIDENTAL CHEMICAL CORP. | A |
| **MECOSTA** | AGCO INC. | S |
| **MENOMINEE** | FIBREK | A |
| | L.E. JONES CO LLC | CO |
| **MIDLAND** | CABOT FUMED SILICA - MIDLAND PLANT | CH |
| | CORTEVA AGRISCIENCE LLC - MIDLAND | A, CH |
| | DDP SPECIALTY ELECTRONIC MATERIALS US LLC | S |
| | MIDLAND COGENERATION VENTURE | F |
| | THE DOW CHEMICAL CO.1790 BUILDING | A, CH, F, S |
| | TRINSEO LLC-MI OPERATIONS | MMA, S |
| | XALT ENERGY LLC | CO |
| **MONROE** | ADVANCED HEAT TREAT CORP. | A |
| | DTE ELECTRIC CO - MONROE POWER PLANT. | A, CO |
| | GUARDIAN INDUSTRIES - CARLETON | A |
| **MUSKEGON** | AMERICAN CHEMICAL SOLUTIONS LLC | P |
| | CANNON-MUSKEGON | CO |
| | HOWMET CORP - PLANTS 1, 3 & 10 | CO |
| | MUSKEGON COMPOSITES INC. | S |
| | TECHLINE PRODUCTS | S |
| | WEBB CHEMICAL SERVICE CORP. | F |
| **OAKLAND** | ENGINEERED HEAT TREAT INC | A |
| | GENERAL MOTORS LLC ORION ASSEMBLY CENTER | F |
| | K C JONES PLATING CO. | A |
| | LYMTAL INTERNATIONAL, INC. | MA |
| | MACDERMID INC. | A |
| | OERLIKON METCO (US) TROY | CO |
| | SPECIALTY STEEL TREATING INC. | A |
| | WOODWORTH INC. | A |
| **OGEMAW** | HYPERION MATERIALS & TECHNOLOGIES - WEST BRANCH | CO |
| **OSCEOLA** | ADVANCED FIBERMOLDING INC. | S |
| | GENERAL MILLS REED CITY YOPLAIT PLANT | A |
| **OTTAWA** | BOAR'S HEAD PROVISIONS CO INC. | A |
| | J H CAMPBELL GENERATING PLANT | A |
| | NPR OF MICHIGAN | CO |
| | REQUEST FOODS INC. (COLDQUEST, GREENLY ST, QUINCY ST) | A |
| | THE HILLSHIRE BRANDS CO. | A |
| | VERTELLUS ZEELAND LLC | MA |
| **SAGINAW** | ADVANCED MICRONUTRIENT PRODUCTS INC | A |
| | STAR OF THE WEST MILLING CO. | CH |
| **SANILAC** | DGP INC. | S |

| COUNTY | COMPANY NAME | EXPOSURES |
|---|---|---|
| | MICHIGAN SUGAR CO-CROSW ELL FACTORY | A |
| | MIDWEST RUBBER CO. | CH |
| **SHIAWASSEE** | GREAT LAKES COMPOSITES LLC | S |
| **ST. CLAIR** | MARYSVILLE ETHANOL LLC | F |
| | MICHIGAN METAL COATINGS | CO |
| | SUNSATION PRODUCTS INC. | MMA, S |
| | ZF AXLE DRIVES MARYSVILLE | A |
| **ST. JOSEPH** | AQUATIC CO. | S |
| **TUSCOLA** | MICHIGAN SUGAR CO - CARO FACTORY | A |
| **VAN BUREN** | ALLOY STEEL TREATING CO. INC. | A |
| **WASHTENAW** | DAPCO INDUSTRIES | A |
| **WAYNE** | AIR PRODUCTS & CHEMICALS INC/DETROIT HYDROGEN FACILITY | A |
| | BASF CORP. | A, M, MMA, S |
| | BODYCOTE THERMAL PROCESSING INC. - CANTON HAGGERTY | A |
| | COOPER HEAT TREATING LLC. | A |
| | DYNAMIC SURFACE TECHNOLOGIES INT. INC. | A |
| | EES COKE BATTERY LLC. | A |
| | EQ DETROIT INC. | CO, S |
| | INLAND WATERS POLLUTION CONTROL DETROIT FACILITY | S |
| | JCI JONES CHEMICALS INC. | CH |
| | L & W INC..6771 HAGGERTY RD | CO |
| | L&W INC.6201 HAGGERTY RD | CO |
| | MARATHON PETROLEUM CO LP - MICHIGAN REFINING DIV. | A |
| | MCGEAN-ROHCO INC. | CO |
| | NEW BOSTON RTM INC. | S |
| | OAKLAND STAMPING LLC | CO |
| | POLYCHEMIE INC. | F |
| | PVS TECHNOLOGIES INC | CH |
| | SATURN ELECTRONICS CORP.. | A |
| | WAYNE DISPOSAL INC. | CO |
| | Z TECHNOLOGIES CORP. | A |
| **WEXFORD** | REC BOAT HOLDINGS LLC-SPORT/ENGINEERING | MMA, S |
| | REC BOAT HOLDINGS-CRUISER PLANT | MMA, S |

[a]Source: US Environmental Protection Agency. Toxics Release Inventory, Michigan. Companies Using Select Toxic Chemicals for Calendar Year 2022, accessed 10/30/2023.

# Discussion

Ongoing surveillance for WRA has identified changes over time. The reports of WRA from exposure to cleaning agents increased while reports of WRA caused by isocyanates, metal working fluids, and welding decreased. In 2020, with the onset of the COVID-19 pandemic, following the adoption of recommendations for increased use of disinfectants, 30% (14/46) of the WRA reports were associated with exposures to cleaners and disinfectants, while previously cleaning agents constituted 13% of all the MI WRA cases. In 2021, 21% (13/62) of cases were identified with exposures to cleaners and disinfectants. In 2022, 32% (23/72) of cases were identified with exposures to cleaners and disinfectants. Cleaners and disinfectants are used in many workplaces, and controlling exposures will depend on the substitution of less hazardous products and limiting use to only the recommended and necessary applications. The decrease over time in reporting WRA for exposures to isocyanates, metal-working fluid and welding fume, which are used in industrial settings, may be due to the ability of these industrial settings to apply engineering and industrial hygiene controls.

The consensus in the medical literature is that the true number of WRA cases is much greater than what is actually reported in public health surveillance systems, including Michigan's. The American Thoracic Society (ATS) consensus statement estimates that for 15% of adults with asthma, the asthma is caused by work exposures.[6] A second ATS consensus statement estimated that 21.5% of adults with asthma have work-aggravated asthma.[7] The combined estimates from these consensus statements would indicate that 36.5% of all adult asthma is work-related. Based on responses from the 2005 Behavioral Risk Factor Surveillance System (BRFSS) random sample of Michigan residents, we estimate that up to 62,000 (95% CI 42,000-83,000) Michigan adults have asthma caused or aggravated by work.[1] Based on the medical literature, we would estimate that there are 97,500 Michigan adults with WRA.[6] Using capture-recapture analysis, we estimate 228-801 adults in Michigan develop WRA each year.[8] Table 24 shows the characteristics of Michigan adults with asthma attributable to work, based on a telephone survey. These characteristics are similar to the cases of WRA identified through our surveillance system.

For the years 2008-2010, 52.5% (95% CI 48.2-56.8%) of Michigan adults who were ever employed and currently have asthma reported that a health care provider told them, or they told a health provider their asthma was caused or made worse by exposures at work.[1] Table 24 shows how this percentage varied by age, gender, race, annual income and education. Among those individuals who responded that their asthma was caused or made worse by work, only 22% had a discussion about work's effect on their asthma with their health care provider.[1] At minimum, the data suggest that providers are not addressing the concerns of their patients and are probably missing the identification of WRA triggers. Because of the frequency with which work exposures are a factor in adults with asthma, the American College of Chest Physicians Consensus Statement concluded that: "The substantial prevalence of WRA supports consideration of the diagnosis in all who present with new-onset or worsening asthma, followed by appropriate investigations and intervention, including consideration of other exposed workers."[9]

National data showed that individuals with work-related asthma had higher mean numbers of days with asthma symptoms. Individuals with more days of symptoms were more likely to not be able to work or perform usual activities and to use more asthma medication.[10,11]

In 2020, we reviewed the Michigan work-related asthma surveillance system from 1988 to 2018.[12] Highlights of the data collected over the 31 years:

- Overall, the confirmed cases of WRA in Michigan have decreased over the 31 years. The cumulative incidence rate of WRA decreased from 3.5 during 1988-1997 to 2.0 cases per 100,000 Michigan workers during 2008-2018. Surveillance systems in other countries have also reported a downward trend in WRA.
- There were decreases in cases from specific exposures to well-known causes of WRA such as isocyanates and metal working fluids and in the cumulative incidence rate in the overall manufacturing sector (11.6 to 5.6 cases

per 100,000 workers). This decrease was consistent with improved workplace engineering and controls such as enclosure of work processes, product substitution and use of personal protective gear.

- However, for cleaning products, which are found across all industries, generally with less standardized work practices than those applied in a manufacturing setting there was an increase over time in the number of cases and percentage of cases associated with cleaning products from 5% to 20%, even before their increased use associated with the COVID-19 pandemic.
- Sixty-six percent of WRA cases had an emergency department visit, with a median of two and an average of five visits, and 35% were hospitalized for their WRA, with a median of one and an average of four hospitalizations.
- Despite the high morbidity and cost of WRA, only 49% had applied for workers' compensation.
- Nine individuals died from an asthma attack from a workplace exposure (the paper describes one of the deaths). The decedents ranged from 19 to 77 years old. Five were men. Five worked in manufacturing and one each worked in construction, agriculture, food services, and automotive repair. Four were exposed to isocyanates, and one case each was exposed to secondhand cigarette smoke, milk tank cleaning agents, construction chemicals, mold machine release spray, and welding fume.
- WRA cases are useful for targeting workplace enforcement inspections. The confirmed cases worked in 2,601 facilities. Michigan OSHA inspected 806 of those facilities. During the inspections, 10,493 co-workers of the index cases completed a confidential respiratory questionnaire; 1,622 (15%) reported being bothered at work by daily or weekly chest tightness, shortness of breath or wheezing, or having new-onset asthma since beginning to work at the facility. Symptomatic co-workers decreased over time from 18% to 12%.

Workers who were reported to the Michigan surveillance system are generally young to middle age White men and women, with the greatest number being reported from the Detroit metropolitan area. However, the rate of WRA among Black/African American workers is 2.5 times greater than among White workers. Based on an analysis conducted for previous annual reports, factors from the WRA surveillance data that would contribute to greater morbidity among Black/African American workers include a greater likelihood of continuing to be exposed to the workplace agent, having a longer time of exposure before leaving work, and being less likely to receive Workers' Compensation.

With changes in the economy, more temporary workers are being hired on an as-needed basis. The transient nature of temporary work underscores the potential for under counting cases of WRA when employees move from job to job, especially those jobs that have a high potential for exposure to sensitizing agents.

Individuals in the Michigan workforce develop their asthma from exposure to agents in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. The predominant causes of WRA are cleaning products (13.5%), isocyanates (12.0%) and metal working fluids (8.5%). Until recently, metal working fluids were the second most frequently reported exposure, and until 2014, isocyanates were the most frequently reported

exposure. The trend of fewer individuals with the known causes of WRA such as isocyanates, metal-working fluids and high molecular weight compounds, would suggest improvements in controls when these agents are used since the number of facilities using isocyanates has increased. The increase in cases secondary to office settings and in services, and the increase in WRA secondary to cleaning agents, suggests that exposures in these situations have proven more difficult to control (Figure 3), as well as increased workers in service industries.

Cleaning agents are one of the major exposures associated with work-related asthma. The COVID-19 pandemic has increased the use of disinfectants across all industries. Disinfectants shown to cause sensitization and asthma are Bleach (Sodium Hypochlorite), Chloramine T, Chlorhexidine, Hexachlorophene, Quaternary Ammonium Chloride Compounds, Formaldehyde Glutaraldehyde, Mixture of Hydrogen Peroxide and Peracetic Acid. We published a paper assessing calls about disinfectants to the Michigan Poison Center (MiPC) in the first part of 2020. The number of disinfectant calls from 2019 to 2020 increased by 42.8%, and the number of calls with symptoms increased by 57.3%. The average number of calls per day doubled after the first Michigan COVID-19 case, from 4.8 to 9.0, and the proportion of calls about disinfectants among all exposure calls to the MiPC increased from 3.5% to 5.0% ($P$ <.001). [13] Previously, in conjunction with four other states that conduct surveillance for work-related asthma, we published a summary of work-related asthma associated with cleaning agents.[14] Work-related asthma was associated with 12.4% of the cases across all five states. Because of concern about the hazards of cleaning agents, not just concern about their potential to cause or aggravate asthma, individual companies have begun to list the ingredients of their products (Unilever, Procter & Gamble and SC Johnson).

## TABLE 24
## Proportion of Asthma Attributable to Work Among Michigan Adults Who Were Ever Employed and Who Currently Have Asthma, Michigan Asthma Call Back Survey, 2008-2010 Combined

| AGE in years | Proportion, % | 95% Confidence Interval |
|---|---|---|
| 18-34 | 39.9 | 29.6-51.1 |
| 35-64 | 61.8 | 57.5-65.9 |
| >=65 | 43.8 | 38.3-49.5 |
| GENDER | | |
| Male | 54.7 | 46.3-62.8 |
| Female | 51.4 | 46.5-56.2 |
| RACE | | |
| White | 50.5 | 45.7-55.2 |
| Black/African American | 58.9 | 46.7-70.1 |
| ANNUAL INCOME | | |
| <$20,000 | 60.6 | 51.1-69.3 |
| $20,000-$34,999 | 60.3 | 50.6-69.1 |
| $35,000-$49,999 | 51.4 | 41.2-61.5 |
| $50,000-$74,999 | 54.7 | 42.2-66.7 |
| >=$75,000 | 44.8 | 37.8-52.0 |
| EDUCATION | | |
| < High School | 62.6 | 46.7-76.3 |
| High School Graduate | 57.4 | 49.1-65.3 |
| Some College | 51.1 | 43.4-58.7 |
| College Graduate | 48.7 | 41.7-55.8 |

We updated the table first presented in the 2002 Work-Related Asthma Annual Report (Table 22) on the number of manufacturing workers in companies that use isocyanates. In Dickinson County 5.8% of the workforce is potentially exposed to isocyanates, and in Isabella and Wexford counties approximately 3.4% of the workforce is exposed. Barry and Sanilac counties each have 2.9% of the workforce employed in facilities where isocyanates are used. Health care providers can use this information to heighten their awareness of potential exposures to isocyanates among their patients with asthma.

Table 23 shows selected agents by county and company that have been associated with WRA. Health care providers can use this table as an initial step in evaluating possible exposure for their patients if they work at one of the facilities listed. Additional information on the chemicals used at a patient's company may be obtained by using the state's online portal for the EGLE FOIA Request Center at https://www.michigan.gov/egle/contact/foia.

Asthma symptoms may persist despite removal from the precipitating work exposures (Tables 15 & 16). Studies show that the sooner an individual is removed from the exposure after symptoms develop, the more likely the individual's symptoms will resolve.[9] Among the 2,463 individuals who are no longer exposed to the causal agent, almost three years elapse from onset of respiratory symptoms at work to date last exposed. We do not have data on how much of this delay is secondary to the individual not seeking medical care and how much is related to the physician not recommending that the individual leave the exposure.

Data from the United Kingdom estimated that when medical care and lost time are factored in, the work-related asthma costs were 100 million dollars per year, with 49% of the cost borne by the patient, 48% by the government and only 3% by the employer.[15] We do not have cost estimates for Michigan, but given the fact that only 49% of individuals applied for Workers' Compensation benefits, and we do not have universal health insurance as in the United Kingdom, we suspect that the individual patients in Michigan bear a high percentage of the costs associated with work-related asthma.

Personal habits like cigarette smoking and individual susceptibility measured through a personal or family history of allergies do not predict who will develop WRA. About 43% of the WRA patients identified through the Michigan Tracking System have no personal or family history of allergies, and 81% are not smoking cigarettes at the time their asthma symptoms develop (Tables 11,13).

Although most facilities where the patient developed asthma were in compliance with exposure standards, there were high percentages of symptomatic co-workers identified in those facilities. It is possible that either air sampling was not conducted under similar enough conditions as the exposures associated with the development of the index cases' asthma, such as spills or leaks, or that the current standards are not protective enough.

There was one WRA inspection each in 2020 and 2021, and two inspections in 2022. The number of inspections has decreased since the COVID-19 pandemic. In previous years, we identified 1,635 fellow workers with symptoms compatible with WRA (Table 21). Five hundred eighty-six individuals were listed on the MIOSHA Log of Work-Related Injuries and Illnesses (Form 300) as having WRA or symptoms compatible with WRA. There was only an overlap of 10 individuals reporting symptoms on co-worker interviews who were also reported on the MIOSHA Log. Part of the reason for the lack of overlap is that half of the symptomatic individuals indicated they had never seen a doctor for their respiratory symptoms.

Medical monitoring is particularly relevant to reducing the burden of work-related causes of asthma. The longer a person with asthma remains exposed, the more likely their asthma will become a chronic problem.[9] A review of companies using isocyanates showed that only 32% were providing periodic medical surveillance.[16]

The percentages of individuals reported with work-related asthma that this surveillance system documented with breathing tests performed in relation to work was less than 10%. This reflects the standard of medical care in the United States, where the diagnosis of WRA is made from the patient's history. More frequent use of objective pulmonary function testing performed in relation to work would allow health care providers to feel more confident when they should advise their patients to leave their work exposure.

Cessation of exposure is the most important aspect of treatment; patients who are removed from exposure the soonest have the best prognosis.[9] Effective asthma treatment requires that the health care providers consider a patient's asthma triggers. Many times, the health care provider reacts to concerns that their patient raises about workplace exposures, rather than proactively inquiring whether their patient has triggers at work that contribute to their respiratory symptoms. One of the factors related to a 2005 death caused by isocyanate exposure was that the primary care physician waited until the patient requested a medical restriction, rather than instructing the patient at an earlier time that he needed to be removed from any further exposure to isocyanates at work.

The report of a patient with known or suspected WRA is a sentinel health event that is critical to effective occupational disease surveillance. Case reporting from physicians offers the opportunity for the timeliest workplace interventions, compared to receiving reports from hospitals.

Reporting can be done online at oem.msu.edu, via email at ODREPORT@msu.edu, via fax at 517-432-3606, via telephone at 1-800-446-7805, or mailed to MIOSHA, Technical Services Division, PO Box 30649, Lansing, MI 48909-8149.

Reporting forms can be found online at oem.msu.edu or by calling the toll-free number, 1-800-446-7805.

With continued support and increasing awareness of WRA by physicians and other health professionals, we can continue to provide timely intervention in the workplace, offer suggestions for reducing workplace exposures even if they are below the current permissible exposure limits, document the need for the development of new standards, identify new occupational allergens, and prevent co-workers from developing disease.

Since July 2020, we have initiated use of the Michigan Emergency Medical Services Information System (MI-EMSIS) as a new source to identify work-related asthma. MI-EMSIS compiles the data from all ambulance runs in the state, which average about 83,000 monthly. An algorithm was developed to select ambulance runs that involve patients with respiratory symptoms from non-residential locations. The narratives from these runs are reviewed to identify potential asthma patients whose asthma is caused by a work exposure. The addition of this data source continues our effort to expand our multiple source surveillance system to minimize the number of cases not being reported.

The potential that 54% of Michigan adults with asthma report that work causes or aggravates their work-related asthma emphasizes the importance that health care providers and all asthma initiatives planned on surveillance and education, both for health care providers and the public, address the importance of work exposures in diagnosing and managing asthma in adults.

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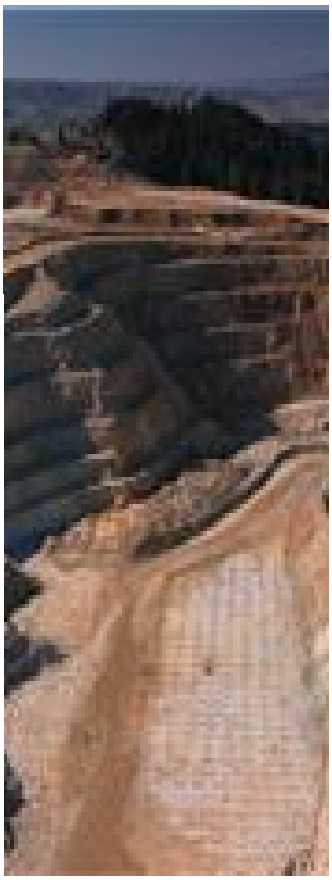
# *APPENDIX*

## 2022 Patient Narratives by Type of Industry & Exposure



Abbreviations:

OA = Occupational Asthma with Exposure to a Known Sensitizer
POA = Possible Occupational Asthma, Work-Related Symptoms, but Exposure is not a Known Sensitizer
AA = Aggravated Asthma (Pre-Existing Asthma Exacerbated at Work)
RADS = Reactive Airways Dysfunction Syndrome

*The patient narratives that follow are based on information collected from interviews and medical records of patients reported with work-related asthma.*



### MANUFACTURING

#### Exposure to isocyanates

OA4507 A male in his 50s developed WRA shortly after beginning to work at a glue manufacturing facility. He described having regular exposures to the glue ingredients, including isocyanates, each time he would pump the ingredients into a vessel from a high-pressure hose and some of the chemicals would spill. These exposures triggered wheezing, cough, shortness of breath and chest tightness. He was treated in the emergency department and prescribed albuterol and Symbicort. He found a different job, and his asthma improved. He was a life-long non-smoker.

#### Exposure to epoxies and glues

EA4476 A female in her 20s experienced an exacerbation of her pre-existing asthma from exposure to urethane where she worked at an auto battery manufacturer. She experienced chest tightness and shortness of breath and was prescribed prednisone and Ventolin in the emergency department. She was a life-long non-smoker.

NO4466 A female in her 40s developed work-related asthma after working three years from exposure to glue used to seal car windows where she worked at an automotive window manufacturer. She developed a cough, chest tightness and shortness of breath and was prescribed albuterol in the emergency department. Her asthma worsened since it developed, and she required a greater amount of asthma medication. She was fired from this job because she contacted Michigan OSHA. She had not found new work at the time of the interview. She was a life-long non-smoker.

EA4436 A male in his 40s experienced an exacerbation of his pre-existing asthma from exposure to glues, solvents and coloring agents where he worked as a production operator at an industrial adhesive manufacturer. He experienced shortness of breath. He was placed on medical leave. He formerly smoked a half pack of cigarettes a day for 25 years.

EA4475 A female in her 30s experienced an exacerbation of her pre-existing asthma while working as an assembler at a hot tub manufacturing facility. Exposure to glue fumes used as a tube sealant would trigger chest tightness and shortness of breath. Respiratory PPE was not provided, and she no longer works for the company. She was treated at the emergency department.

### Exposure to welding fume

OA4531 A male in his 30s developed work-related asthma from exposure to welding fumes and dust at the auto parts manufacturer where he worked as a Hi-Lo operator. His exposure was not limited to one area of the building. Exposure triggered cough, chest tightness, and shortness of breath. He sought treatment at the emergency department and was prescribed a rescue inhaler. He formerly smoked 5 cigarettes a day for 10 years.

EA4447 A male experienced an exacerbation of his pre-existing asthma from exposure to welding fumes where he worked at a sugar manufacturer. He experienced chest tightness and sought treatment at the emergency department. He was a former smoker.

### Exposure to plastic dust and fumes

EA4453 A male in his 40s experienced an exacerbation of his pre-existing asthma from exposure to plastic dust and fumes at the plastic parts manufacturer where he worked as a machine operator. He immediately experienced chest tightness and shortness of breath when the machines were being cleaned and there was a lot of dust dispersed into the air. He was treated in the emergency department.

EA4482 A female in her 40s experienced an exacerbation of her pre-existing asthma after exposure to plastic fumes working at a plastic injection molding company. She experienced shortness of breath and was treated with albuterol in the emergency department. She was a lifelong non-smoker.

NO4496 A male in his 60s developed work-related asthma after exposure to grinding dust, fumes, and mold at a plastic fabrication facility where he worked as a machine repair mechanic for over 30 years. Exposure triggered wheezing, cough, chest tightness, and shortness of breath. He was given a rescue inhaler treated with Singulair and an inhaled steroid at the emergency department. His asthma worsened, and he required more asthma medication. He was a lifelong non-smoker.

### Exposure to miscellaneous chemicals and dusts in the food, plant or pharmaceutical manufacturing industry

EA4444 A male in his 20s experienced an exacerbation of his pre-existing asthma from exposure to cannabis dust, heat and humidity while tending plants at a marijuana grow facility. He was prescribed an albuterol inhaler in the emergency department. He was a life-long non-smoker.

EA4457 A female in her 30s experienced an exacerbation of her pre-existing asthma while working at a pharmaceutical and food packaging manufacturer & distribution center. Exposure to unknown irritants triggered wheezing and shortness of breath. She was treated at the emergency department.

EA4477 A female in her 40s experienced an exacerbation of her pre-existing asthma while working as a cultivation technician in an indoor cannabis grow facility. Exposure to mold and fungicide in the facility would immediately trigger wheezing, chest tightness, and shortness of breath. She was treated with Singulair and prescribed a rescue inhaler. She had formerly smoked an average of 5 cigarettes per day between her teens and 30s.

EA4489 A female in her 20s experienced an exacerbation of her pre-existing asthma from airborne spice dust while working as a security guard at a meat processing facility. Acute exposure would trigger wheezing, shortness of breath, chest tightness, and cough. She was prescribed Symbicort and treated at the emergency department. She was a lifelong non-smoker.

OA4488 A male in his 30s developed work-related asthma working with psyllium while employed at a cereal manufacturer. He experienced wheezing and shortness of breath. Treatment of albuterol and DuoNeb was given at the emergency department. He was a lifelong non-smoker.

EA4498 A male in his 30s died from an exacerbation of his childhood asthma, four months after he started working at a breakfast food manufacturer where he was exposed to cereal dust. He worked in the milling department. He sought medical care since starting the job, and was prescribed DuoNeb and Prednisone, but nothing was done to advise him of the dangers of continuing to work in this exposure. He smoked cigarettes.

EA4587 A male in his 40s experienced an exacerbation of his pre-existing asthma from exposure to construction dust at a food manufacturing plant. The dust triggered chest tightness and shortness of breath. He was prescribed albuterol and prednisone in the emergency department. He smoked a pack of cigarettes per day.

### Exposure to cleaning agents

EA4446 A female in her 40s experienced an exacerbation of her pre-existing asthma working for a boat building company, from exposure to a cleaning agent that contained quaternary amines. She used this cleaner on boats. It triggered a cough, chest tightness and shortness of breath. She was prescribed albuterol in the emergency department. She was a life-long non-smoker.

EA4469 A male in his 30s experienced an exacerbation of his pre-existing asthma working at a boat building company, after exposure to improperly mixed cleaning agents. These cleaning agents were used on boats. Exposure triggered wheezing, cough, and shortness of breath. He was treated at the emergency department. He was a lifelong smoker.

EA4481 A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to cleaning products following a chemical spill at an automotive parts manufacturer. She experienced shortness of breath and cough. Treatment of albuterol was administered at the emergency department. She was a lifelong non-smoker.

### Exposure to miscellaneous chemicals and dusts

EA4445 A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to a coworker's cologne at an auto manufacturing plant where she drove a forklift. Whenever the coworker worked near her, it would trigger wheezing, a cough, chest tightness and shortness of breath. She was a life-long non-smoker.

EA4511 A female in her 50s experienced an exacerbation of her pre-existing asthma after being exposed to a coworker's cologne at an auto manufacturing plant where she worked. Being in the vicinity of the coworker triggered shortness of breath. She was treated with Benadryl, albuterol, and a steroid at the emergency department. She was a lifelong non-smoker.

NO4449 A female in her 40s developed work-related asthma from an unknown exposure at the auto manufacturer where she worked. She experienced shortness of breath and was treated at the emergency department. She was given prednisone.

EA4538 A female in her 20s experienced an exacerbation of her pre-existing asthma from exertion while moving pallets at an automotive interior parts manufacturer. She sought treatment at the emergency department.

NO4468 A male in his 30s developed work-related asthma working at a chemical manufacturing facility. He experienced wheezing, cough, and shortness of breath. Treatment of albuterol and prednisone was administered by emergency room services. He had been previously diagnosed with chronic respiratory failure.

EA4479 A female in her 20s experienced an exacerbation of her pre-existing asthma working at an auto parts manufacturer. She experienced wheezing and shortness of breath after exposure to factory dust and fumes. She was treated with albuterol and prednisone at the emergency department. She was a lifelong non-smoker.

EA4459 A male in his 20s experienced an exacerbation of his pre-existing asthma working at an auto parts manufacturing and assembly plant. He experienced shortness of breath and sought treatment at the emergency department. He was a lifelong non-smoker.

EA4487 A female in her 20s working as an assembler operator at an auto parts manufacturer experienced an exacerbation of her pre-existing asthma. Exposure to dust in the facility triggered wheezing and shortness of breath. She was treated at a local urgent care facility. Her asthma worsened, and she required a greater amount of asthma medication. She was a lifelong non-smoker.

NO4493 A female in her 60s experienced an exacerbation of her pre-existing asthma while employed at an automotive navigation parts manufacturer where painting, coating, and finishing products were used. Exposure to paint fumes in the facility triggered cough and shortness of breath. She was treated at the emergency department with albuterol. She smoked half a pack of cigarettes per day on average.

EA4509 A female in her 30s experienced an exacerbation of her pre-existing asthma from exposure to an unknown chemical while working at an auto manufacturer. Exposure to the chemical triggered chest tightness. She was treated at the emergency department with albuterol and a steroid. She was a lifelong non-smoker.

NO4510 A male in his 20s developed work-related asthma after exposure to dust and gas exhaust fumes at an automotive manufacturer where he was employed as a production assembly worker. He experienced wheezing, cough, chest tightness, and shortness of breath while working on the production line. His asthma worsened, and he required a greater amount of asthma medication. He was treated at the emergency department with an inhaler. He formerly smoked 5 cigarettes a day between the ages of 18-19.

EA4512 A female in her 50s experienced an exacerbation of her pre-existing asthma while working as a quality control inspector for an automotive manufacturer. Exposure to smoke triggered wheezing, cough, shortness of breath, and chest tightness. She was treated with albuterol, Wixella, and an inhaled steroid. She formerly smoked.

EA4513 A male in his 30s experienced an exacerbation of his pre-existing asthma after exposure to dust and fumes from Hi-Lo forklifts at an automotive parts manufacturer where he worked as a machine operator. He experienced cough, wheezing, chest tightness, and shortness of breath. He sought treatment at the emergency department. He was a lifelong non-smoker.

EA4573 A male in his 50s experienced an exacerbation of his pre-existing asthma from his job at a paper mill. He experienced shortness of breath. He was prescribed a rescue inhaler in the emergency department. He was a non-smoker.

## EDUCATIONAL SERVICES

### Exposure to animal dander

OA4485 A female in her 20s developed work-related asthma while working as a college graduate assistant. She was in contact with rats for multiple hours each day for a month at a time as a research aid. Exposure would trigger wheezing and shortness of breath. She sought treatment and was prescribed a rescue inhaler. She was a lifelong non-smoker.

### Exposure to cleaning agents and disinfectants

OA4527 A female in her 50s developed work-related asthma from exposure to mold, disinfectants, and other cleaning products where she worked at a secondary school as a school cafeteria manager. Exposure triggered wheezing and shortness of breath. She was treated with albuterol at the emergency department. She was a smoker and consumed a pack a day on average.

## HEALTH CARE SERVICES

### Exposure to disinfectants

OA4443 A female developed work-related asthma in her 50s from exposure to disinfectants at the hospital where she worked as a housekeeper. Her asthma developed after working at the hospital for over 20 years. She formerly smoked a pack and a half of cigarettes for over 15 years from her teens to her 30s.

OA4441 A male in his 50s developed work-related asthma after exposure to undiluted oxycide disinfectant while working as a hospital nurse. He immediately experienced chest tightness, cough, and shortness of breath. He was treated with prednisone, a rescue inhaler, Singulair, and an inhaled steroid. He was a lifelong non-smoker.

OA4495 A female in her 30s developed work-related asthma after working for 10 years as an in-home care aid. Exposure to cleaning chemicals, bleach and ammonia triggered wheezing, cough, shortness of breath, and chest tightness. She sought treatment at the emergency department on multiple occasions and was prescribed Ventolin and Advair. Her asthma worsened, and she required a greater amount of asthma medication. She was a lifelong non-smoker.

EA4506 A female in her 40s experienced an exacerbation of her pre-existing asthma while working as a full-time in-home caregiver. She accidentally mixed bleach and Lysol, which immediately triggered wheezing, cough, chest tightness, and shortness of breath. She was treated in the emergency department, who consulted with the Michigan Poison Control Center regarding her exposure. She was a lifelong smoker.

### Exposure to indoor air contaminants and miscellaneous chemicals and dust

EA4478 A female in her 40s experienced an exacerbation of her pre-existing asthma working at a rehabilitative center as an overnight health aid, from exposure to human waste. She experienced wheezing, cough, shortness of breath, and chest tightness. She was treated with prednisone and albuterol at the emergency department. She formerly smoked half a pack of cigarettes per day in her teens.

NO4465 A female in her 40s developed work-related asthma while employed at a nursing home where she worked in the office. The office was located in a poorly ventilated basement where flooding was common, and mold was present. At work, she experienced coughing, wheezing, shortness of breath, and chest tightness. She was given a rescue inhaler, treated with loratadine, and given an inhaled steroid and bronchodilator. Her asthma has worsened, and she required a greater amount of asthma medication. She was a lifelong non-smoker.

EA4524 A female in her 50s experienced an exacerbation of her pre-existing asthma from exposure to generator fumes at a hospital where she worked as a secretary. Exposure triggered coughing. She was treated at the emergency department. She was a lifelong non-smoker.

## AGRICULTURE

### Exposure to disinfectants

EA4467 A female in her 20s experienced an exacerbation of her pre-existing asthma from exposure to a disinfectant that was being used at a dairy farm. She developed wheezing and shortness of breath and sought treatment at an urgent care facility. She was a life-long non-smoker.

EA4460 A male in his 20s experienced an exacerbation of his pre-existing asthma from exposure to AC 103 caustic chemical foam drain cleaner being used at a dairy processing facility. He worked as a pasteurizing process operator. Exposure immediately triggered cough, chest tightness, and shortness of breath. His asthma worsened from this exposure, and he required a greater amount of asthma medication. He was treated with an inhaled steroid and bronchodilator. He was a lifelong non-smoker.

### Exposure to miscellaneous substances

EA4454 A male in his 20s experienced an exacerbation of his pre-existing asthma from exposure to an unknown chemical at a greenhouse where he worked. He experienced a cough and was prescribed albuterol and prednisone at the emergency department. He was a life-long non-smoker.

## WHOLESALE AND RETAIL SERVICES

### Exposure to disinfectants

EA4505 A male in his 50s experienced an exacerbation of his pre-existing asthma after a coworker used bleach nearby while he was working in a grocery store. The exposure immediately triggered a cough, shortness of breath, and chest tightness. He sought treatment at an emergency department who consulted with the Michigan Poison Control Center regarding the exposure; he was prescribed a steroid. He was a lifelong non-smoker.

### Exposure to cleaning agents

EA4474 A female in her 50s experienced an exacerbation of her pre-existing asthma after she was exposed to floor stripping agents at the retail pharmacy where she worked. Exposure triggered cough and shortness of breath. She was treated by the emergency department with prednisone and albuterol. She was a lifelong non-smoker.

### Exposure to miscellaneous substances including chemicals and dust

OA4448 A male in his 20s developed work-related asthma from exposure to pet dander and cleaning agents while working at a retail pet store, cleaning cages where the animals were housed. He experienced shortness of breath and was treated at the emergency department.

NO4483 A female in her late teens developed work-related asthma working in a wholesale distribution center. She experienced wheezing and shortness of breath. She believes this was triggered by exposure to dust and metal shavings while cleaning and moving equipment. She sought treatment at the emergency department and was given albuterol. She was a lifelong non-smoker.

EA4431 A female in her 20s experienced an exacerbation of her pre-existing asthma from dust exposure and cold temperatures while working in a cold storage distribution warehouse. This triggered chest tightness and an increased frequency of asthma attacks. She was treated at the emergency department with albuterol. She was a lifelong non-smoker.

EA4486 A female in her 40s experienced an exacerbation of her pre-existing asthma while employed at a drug store after exposure to aerosol sprays. Exposure triggered wheezing and shortness of breath. She sought treatment at the emergency department and was treated with a rescue inhaler. She was a lifelong non-smoker.

## CONSTRUCTION

### Exposure to miscellaneous chemicals and dust

EA4528 A male in his 20s experienced an exacerbation of his pre-existing asthma after exposure to industrial chemicals MDI and polyurethane resin B while working for a construction company. When exposed, these chemicals triggered a cough, shortness of breath, and chest tightness. He was treated at the emergency department and was prescribed a steroid and albuterol. He used a vaping device.

RA4503 A male in his 40s developed reactive airways dysfunction syndrome after an acute exposure to a hydrochloric acid spill while working as an insulator on a construction site. Exposure triggered shortness of breath. He was treated at the emergency department with albuterol and prednisone. He formerly smoked a pack of cigarettes per day for 30 years.

EA4504 A male in his 40s experienced an exacerbation of his pre-existing asthma after exposure to asbestos, black mold, and lead while working at a commercial building construction site where he worked as a foreman. Respiratory PPE was not provided. He immediately experienced wheezing, shortness of breath, cough, and chest tightness. Treatment of Ventolin and Advair was given at the emergency department. His breathing problems worsened, and he required a greater amount of asthma medication.

## FOOD & ACCOMMODATIONS SERVICES

### Exposure to miscellaneous substances

EA4456 A female in her 30s experienced an exacerbation of her pre-existing asthma while working as a busser in a restaurant. Exposure to the hot environment triggered cough, wheezing, chest tightness, and shortness of breath. She sought treatment on multiple occasions at the emergency department and was given albuterol. She formerly smoked half a pack of cigarettes per day between the ages of 18-25.

## PUBLIC SERVICES

### Exposure to miscellaneous substances

EA4484 A male in his 20s working as an emergency services firefighter and first responder experienced an exacerbation of his pre-existing asthma due to smoke inhalation. Smoke inhalation would immediately trigger shortness of breath, chest tightness, and cough. He sought treatment at the emergency department and was prescribed an inhaled steroid. He had previously been diagnosed with childhood asthma by a doctor.

OA4430 A female in her 40s developed work-related asthma after working as a police dispatch operator in a building with poor ventilation. This triggered wheezing, cough, shortness of breath, and chest tightness. She was exposed to disinfectants used in the poorly ventilated space. She was treated with an inhaled steroid, prednisone, and an albuterol nebulizer in the emergency department. She was prescribed a rescue inhaler.

EA4502 A male in his 20s experienced an exacerbation of his pre-existing asthma following a fire where he worked as a corrections officer. Smoke inhalation and fumes from the use of fire extinguishers triggered wheezing and shortness of breath. He was treated at the emergency department with inhaled steroids and albuterol.

RA4525 A male in his 20s developed reactive airways dysfunction syndrome from exposure to smoke from a fire. He worked as a firefighter and paramedic at a fire department and wore a full hood respirator as PPE. Smoke inhalation immediately triggered cough, wheezing, chest tightness, and shortness of breath. He was treated with Ventolin at the emergency department. He was a lifelong non-smoker.

## TRANSPORTATION AND WAREHOUSING

### Exposure to cleaning products including disinfectants

NO4497 A male in his 50s developed work-related asthma after exposure to vaporized cleaning chemicals while working as a bus driver. He was required to chemically clean the school bus 3-4 times per day in a poorly ventilated space. Exposure triggered wheezing, cough, shortness of breath, and chest tightness. He sought multiple treatments at the emergency department and was given albuterol. He required a greater amount of asthma medication and was a lifelong non-smoker.

EA4576 A female in her 60s experienced an exacerbation of her pre-existing asthma from exposure to bathroom cleaner fumes at the auto parts warehouse where she had worked for three years. Exposure to the cleaner caused her to have shortness of breath. She was prescribed albuterol.

### Exposure to miscellaneous substances

NO4438 A female in her 20s developed work-related asthma working for a steamship ore transportation company. Her job was to supervise loading and unloading of transported ores. Exposure to ore dust and mold in the ventilation system would trigger a cough and shortness of breath. She sought treatment and was prescribed an inhaled steroid and rescue inhaler. She was a lifelong non-smoker.

## MISCELLANEOUS SERVICES AND INDUSTRIES

### Exposure to cleaning products including disinfectants

RADS4450 A female developed reactive airways dysfunction syndrome in her 40s from an acute exposure to a mixture of cleaning agents, bleach and toilet bowl cleaner, while working for a janitorial service. She immediately experienced shortness of breath and was prescribed a rescue inhaler at the emergency department. She retired from this job as a cleaning custodian for buildings. She formerly smoked till her early 50s.

EA4499 A female in her 40s experienced an exacerbation of her pre-existing asthma following exposure to cleaning chemicals while working for a home cleaning service. The mixing of bleach and toilet bowl cleaner immediately triggered cough, wheezing, shortness of breath, and chest tightness. She was treated at the emergency department. She formerly smoked less than half a pack of cigarettes per day.

EA4530 A female in her 30s experienced an exacerbation of her pre-existing asthma from exposure to undiluted industrial strength cleaning chemicals where she worked cleaning buildings. Exposure triggered cough and shortness of breath. She was treated at the emergency department with albuterol and Atrovent. She was a lifelong smoker.

### Exposure to miscellaneous substances

EA4458 A male in his 20s experienced an exacerbation of his pre-existing asthma while working at an adoption agency. He was employed as a maintenance worker and was routinely exposed to drywall dust and fiberglass insulation. Exposure would trigger wheezing, a cough, chest tightness, and shortness of breath. He sought treatment at a local urgent care. He was a lifelong non-smoker.

NO4508 A female in her 60s developed work-related asthma after exposure to paint fumes at a glass studio where she was painting cabinets. The exposure triggered shortness of breath and a cough. She was treated with Wixela and albuterol. She formerly smoked half a pack of cigarettes per day for 2 years in her 20s.

EA4515 A male in his 20s experienced an exacerbation of his pre-existing asthma from exposure to epoxy glaze where he worked at a facility that reglazed bathtubs. Exposure triggered coughing, wheezing, and shortness of breath. Respiratory PPE was provided. He was treated at the emergency department with Advair. He was a lifelong non-smoker.

EA4529 A male in his 60s experienced an exacerbation of his pre-existing asthma from exposure to paint fumes at a gravel pit. Exposure triggered shortness of breath. He sought treatment at the emergency department and was given albuterol. He was a lifelong non-smoker.

NO4566 A male in his 60s developed WRA after working for 10 years at a company, cleaning the insides of tanks on trucks that haul any type of liquid. He developed wheezing and shortness of breath, which worsened during each shift. He was treated in the emergency department twice. He formerly smoked an average of five cigarettes per day from his late-teens to his mid-30s.

NO4540 A male in his 60s developed WRA from exposure to bat urine and feces while doing stained glass repair work in the attic of a church. He developed a cough, chest tightness and shortness of breath. He was prescribed albuterol and Spiriva in the emergency department. His asthma improved after the job was completed at the church. He formerly smoked a pack of cigarettes per day for 40 years, from his mid-teens to his mid-50s.