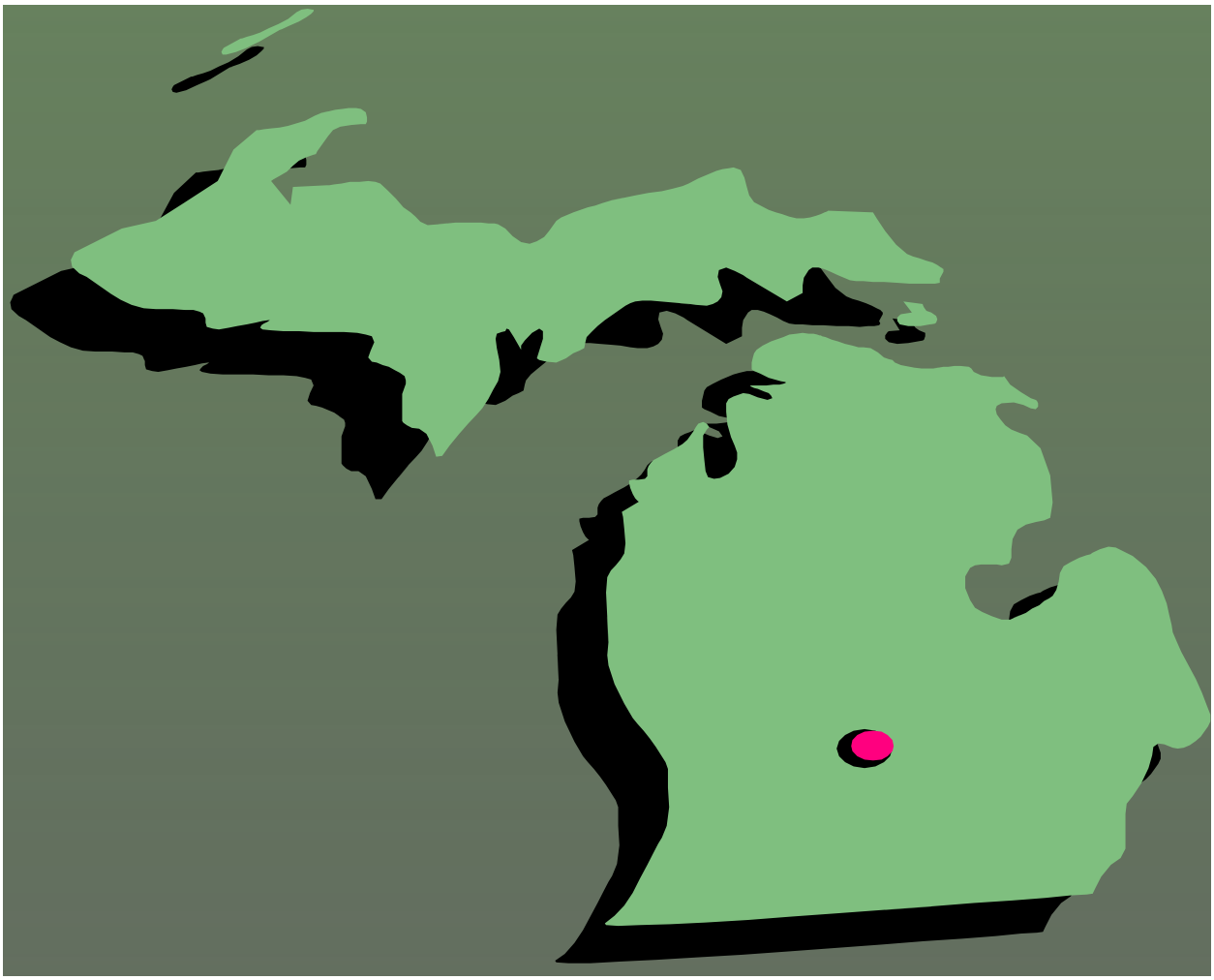
August 25, 2023

2021 Annual Report

Tracking work-related asthma in Michigan



2021 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 31st 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.

- Since 2007, the number of cases identified each year has been declining.
- From 1988-2021, 3,882 WRA cases have been identified with MI's tracking system.
- We estimate there are 62,000-97,000 adults in MI with WRA.
- 78% of the MI WRA patients have new-onset asthma; 22% 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 (13.1%) and isocyanates (11.7%), are the most commonly reported exposures causing WRA in MI.
- The average incidence rate of WRA among African Americans is 2.2 times greater than that of Caucasians.

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**

New Onset

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]

Exacerbation

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

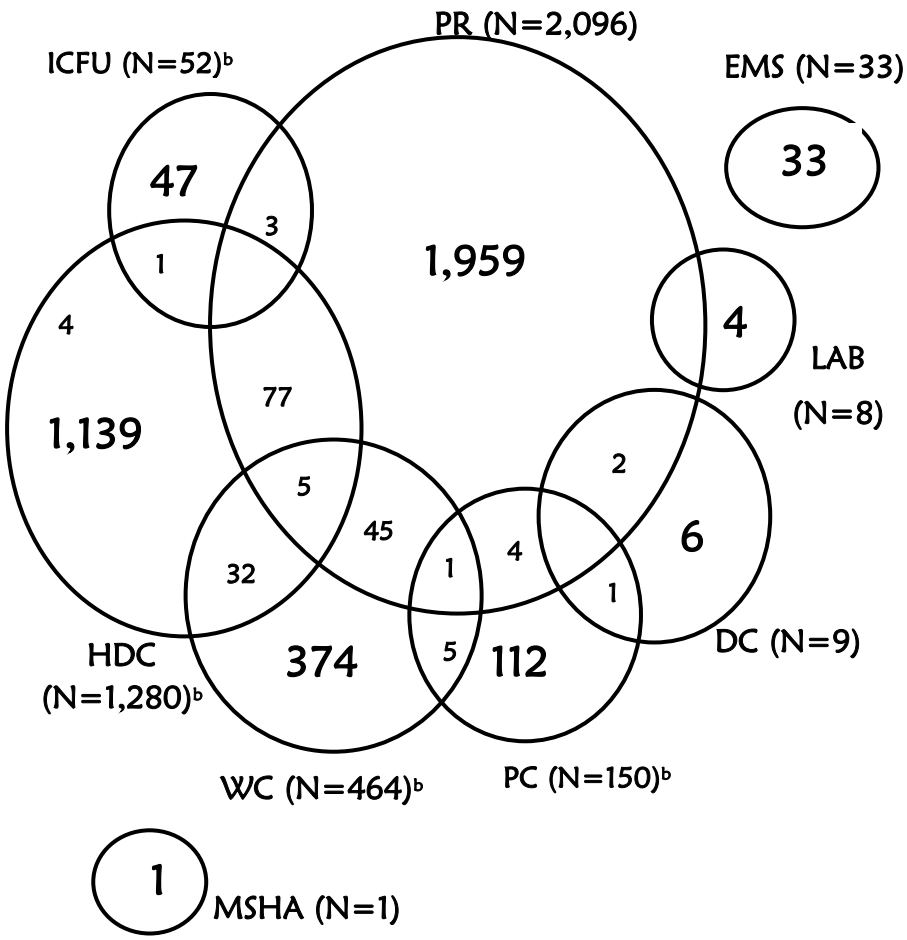
Table 1 shows that 3,882 people were confirmed with WRA between 1988—2021. The reports are divided into: occupational asthma (OA), possible occupational asthma (POA), aggravated asthma (AA) and Reactive Airways Dysfunction Syndrome (RADS). Ninety-two additional patients have been confirmed since last year's report (all 62 for 2021). Figure 1 shows the overlap of the patients by reporting sources for 1988—2021.

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
Total	1,239	1,349	868	426	3,882

[a]Reports are still being processed for calendar years 2020 and 2021 an increase in these totals will be reflected in next year's annual report.

FIGURE 1
Overlap of Reporting Sources for 3,882 Confirmed WRA Patients: 1988-2021[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 24 individuals, an overlap of one individual for PC-ICFU, 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 and 2008-2021 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 and 1,147 reported from 2008 to 2021. 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 2008-2021 time periods.

GENDER: Table 2 shows a higher percentage of women were reported with work-related asthma compared to men. Over time, the percentage of women reported with WRA has increased, while the percentage of men has decreased accordingly.

RACE: Table 3 shows there was a slight increase over time in the percentage of Hispanic and African American cases of WRA, and a decrease in the percentage of Caucasian 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 for African Americans was 2.62 per 100,000 Michigan African American workers compared to 1.19 per 100,000 for Michigan Caucasian workers; this was a 2.2 times greater incidence (95% CI 1.252,3.856).

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.

TABLE 2
Gender of WRA Patients by Time Period

	Time Period				
	All years	1988-1997	1998-2007	2008-2021	Change in Percentage
Gender	# (%)	# (%)	# (%)	# (%)	
Female	2,096 (54)	626 (49)	800 (55)	670 (58)	+ 18%
Male	1,786 (46)	648 (51)	661 (45)	477 (42)	- 18%

TABLE 3
Race of WRA Patients by Time Period

	Time Period				
	All years	1988-1997	1998-2007	2008-2021	Change in Percentage
Race	# (%)	# (%)	# (%)	# (%)	
Caucasian	2,779 (72)	973 (76)	1,074 (74)	732 (64)	-14%
African American	742 (19)	239 (19)	271 (19)	232 (20)	None
Hispanic	88 (2)	24 (2)	27 (2)	37 (3)	+ 50%
Alaskan/Am Indian	34 (1)	10 (1)	13 (1)	11 (1)	None
Asian	15 (<1)	4 (0.3)	7 (0.5)	4 (0.3)	+ 33%
Other	42 (1)	11 (1)	20 (1)	11 (1)	None
Unknown	182 (5)	13 (1)	49 (3)	120 (10)	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 (9.7 cases per 100,000), Clare (7.7 cases per 100,000), Huron (5.4 cases per 100,000), Montmorency (5.1 cases per 100,000), Osceola (4.7 cases per 100,000), Genesee (4.5 cases per 100,000) and Saginaw (4.5 cases per 100,000).

TABLE 4

Average Annual Incidence Rates of WRA Among Michigan Workers by County of Exposure: 1989-2019[a]

County	# EE's[b]	Avg Annual Inc Rate[c]	Cases 1989-2019	County	# EE's[b]	Avg Annual Inc Rate[c]	Cases 1989-2019
Alcona	3,734	0.9	1	Keweenaw	944	3.4	1
Alger	4,048	2.4	3	Lake	3,998	1.6	2
Allegan	49,958	3.6	56	Lapeer	41,905	2.9	38
Alpena	13,970	2.5	11	Leelanau	10,874	2.1	7
Antrim	11,088	1.5	5	Lenawee	45,730	2.5	35
Arenac	7,103	2.7	6	Livingston	89,055	1.5	41
Baraga	3,556	3.6	4	Luce	2,654	9.7	8
Barry	28,596	1.1	10	Mackinac	5,885	2.7	5
Bay	51,802	1.7	28	Macomb	396,780	2.5	313
Benzie	8,227	1.6	4	Manistee	10,779	1.2	4
Berrien	72,422	1.4	31	Marquette	32,565	2.3	23
Branch	21,277	3.9	26	Mason	13,773	1.6	7
Calhoun	66,888	2.6	53	Mecosta	18,531	1.6	9
Cass	25,616	0.6	5	Menominee	12,597	0.3	1
Charlevoix	13,105	2.5	10	Midland	38,738	2.8	34
Cheboygan	11,681	3.6	13	Missaukee	6,201	2.1	4
Chippewa	15,906	1.4	7	Monroe	72,474	1.6	35
Clare	12,133	7.4	28	Montcalm	27,319	2.0	17
Clinton	34,977	0.9	10	Montmorency	3,817	5.1	6
Crawford	6,234	3.1	6	Muskegon	82,728	1.1	27
Delta	18,700	2.1	12	Newaygo	21,238	2.7	18
Dickinson	13,496	3.6	15	Oakland	606,421	2.4	455
Eaton	55,176	0.8	13	Oceana	12,741	1.8	7
Emmet	18,249	1.4	8	Ogemaw	8,987	3.6	10
Genesee	194,369	4.5	273	Ontonagon	3,300	1.0	1
Gladwin	9,983	1.0	3	Osceola	9,575	4.7	14
Gogebic	7,217	1.3	3	Otsego	11,720	3.0	11
Gd Traverse	44,511	1.7	23	Ottawa	126,705	0.8	32
Gratiot	18,680	2.1	12	Roscommon	10,306	2.6	8
Hillsdale	20,675	2.0	13	Saginaw	90,548	4.4	124
Houghton	16,137	1.6	8	Sanilac	19,894	3.4	21
Huron	15,636	5.4	26	Schoolcraft	3,588	1.8	2
Ingham	143,327	3.3	145	Shiawassee	33,900	0.6	6
Ionia	28,133	1.6	14	St. Clair	78,920	2.5	61
Iosco	9,617	1.7	5	St. Joseph	28,932	1.4	13
Iron	5,480	2.4	4	Tuscola	26,833	2.9	24
Isabella	35,007	2.8	30	Van Buren	37,417	0.9	11
Jackson	72,274	2.5	55	Washtenaw	179,602	3.6	198
Kalamazoo	123,752	1.5	57	Wayne	837,179	3.3	863
Kalkaska	8,036	3.6	9	Wexford	13,468	1.7	7
Kent	297,020	1.2	112	***All Counties[d]***	**4,706,000[e]**	**2.5**	**3,660**

[a] 1989 through 2019 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2020 and 2021 is not yet complete. Therefore, 1988, 2020 and 2021 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 1989-2019 (31 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 1989-2019 reporting period.

[e] Total is rounded up.

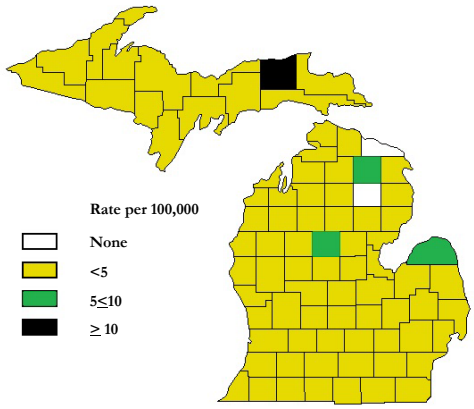
Type of Industry – Trends

TOP 10 COUNTIES: Table 5 shows the top 10 counties with the highest overall rates of WRA that had more than one case during the 1989-2019 time period. All of the top counties with the highest overall rates of WRA had a decrease of 10% or greater, except for Huron and Montmorency counties, in the rate of WRA over time. Many of the rates increased during the 1998-2007 time period but then decreased during the 2008-2021 time period.

Table 6 shows the Michigan industries by NAICS

FIGURE 2

Average Annual Incidence Rate of WRA by County of Exposure: 1989-2019[a]



[a] 1989 through 2019 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2020 and 2021 is not yet complete. Therefore, 1988, 2020 and 2021 reports are not included in this figure.

TABLE 5

Average Annual Incidence Rate of WRA by County and Time Period

	All years	1988-1997			1998-2007			2008-2021			
County	Rate	# Cases	# EE's[a]	Rate	# Cases	# EE's[b]	Rate	# Cases	# EE's[c]	Rate	Change in Percentage
Branch	3.9	7	17,699	4.0	12	21,340	5.6	7	18,243	2.7	- 33%
Cheboygan	3.6	8	9,658	8.3	2	11,422	1.8	3	9,750	2.2	- 73%
Clare	7.4	8	9,100	8.8	11	11,761	9.4	10	10,912	6.5	-26%
Genesee	4.5	83	179,394	4.6	132	191,377	6.9	66	168,867	2.8	- 39%
Huron	5.4	7	14,941	4.7	8	15,499	5.2	12	15,546	5.5	+17%
Kalkaska	3.6	4	6,188	6.5	4	7,932	5.0	1	7,070	1.0	- 85%
Luce	9.7	4	2,021	19.8	2	2,660	7.5	2	2,297	6.2	- 69%
Montmorency	5.1	0	2,868	--	2	3,781	5.3	4	2,772	10.3	+94
Osceola	4.7	2	9,343	2.1	10	9,938	10.1	2	9,537	1.5	- 29%
Saginaw	4.4	31	91,307	3.4	67	90,388	7.4	32	83,622	2.7	- 24%
Sanilac	3.4	5	17,992	2.8	12	19,452	6.2	5	18,310	2.0	- 29%
All MI Counties	2.5	1,274	4,258,000	3.0	1,461	4,702,000	3.1	1,128	4,408,000	1.8	-40%

[a] EE's =employees. Source: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 1992.

[b] Source: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 2008.

[c] Source: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 2010.

codes, with cases of work-related asthma from 1988 to 2021. The main industries were in manufacturing (55%) and health care and social assistance (13%).

The incidence rate of WRA by industry ranges from 0.1 cases per 100,000 in management of companies to a high of 9.6 cases per 100,000 in manufacturing. Industries with the next highest average annual incidence rates were: mining with 6.6 cases per 100,000 workers and health care and social assistance with 3.2 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 36.8% in 2008-2021. Increases in the percentages of cases with WRA occurred in many industry sectors, including: retail trade, administrative and support and waste management, health care and social assistance, and accommodation and food services.

TABLE 6
Number of WRA Patients, 1988-2021 by Primary Industrial Exposure and Average Annual Incidence Rate per 100,000 Workers, 1989-2019 (Years of Complete Reporting)

2002 N American Industry Classification System		WRA Cases 1988-2021		Number of Employees[a]	Average Ann. Incidence Rate[b]	
		#	%		Rate	# Cases
11	Agriculture, Forestry, Fishing, & Hunting	34	0.9	79,883	1.2	30
21	Mining	13	0.3	6,400	6.6	13
22	Utilities	23	0.6	35,300	2.1	23
23	Construction	110	2.8	189,690	1.7	101
31-33	Manufacturing	2,141	55.2	695,885	9.6	2,075
42	Wholesale Trade	42	1.1	169,735	0.8	40
44-45	Retail Trade	130	3.3	512,474	0.8	124
48-49	Transportation & Warehousing	83	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	36
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	96	2.5	271,673	1.1	91
61	Educational Services	172	4.4	437,200	1.2	166
62	Health Care & Social Assistance	484	12.5	480,330	3.2	470
71	Arts, Entertainment & Recreation	34	0.9	61,137	1.8	34
72	Accommodation & Food Services	128	3.3	339,052	1.0	122
81	Other Services (except Public Admin)	96	2.5	178,600	1.6	88
92	Public Administration	153	3.9	252,700	1.9	147
00	Unknown	26	0.7	--	--	25
Total		3,882		4,456,600	2.7	3,743

[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 2020 and 2021 is not yet complete. Therefore, 1988, 2020 and 2021 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 1989-2019 (31 years), per 100,000 Michigan workers.

TABLE 7
2,075 WRA Patients from Manufacturing Industries: 1989-2019[a]

2002 North American Industry Classification System		# WRA Cases	Avg Ann Rate[a]	# Employees[b]
311	Food Mfg	73	7.2	32,729
323	Printing & Related Support Activities	19	3.3	18,327
325	Chemical Mfg	111	12.9	27,704
326	Plastics & Rubber Products Mfg	121	9.1	43,056
327	Nonmetallic Mineral Product Mfg	19	3.7	16,512
331	Primary Metal Mfg	73	8.5	27,648
332	Fabricated Metal Product Mfg	125	4.9	83,121
333	Machinery Mfg	159	6.8	75,925
334	Computer & Electronic Product Mfg	16	2.7	19,165
336	Transportation Equipment Mfg	1,183	14.9	255,913
337	Furniture & Related Product Mfg	17	2.1	26,167
	Miscellaneous Mfg (*includes NAICS: 312-16,321-322,324,335,339)	159	7.4	69,619

[a]Average annual incidence rate, based on cases from 1989-2019 (31 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 2020 and 2021 is not yet complete. Therefore, 1988, 2020 and 2021 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		2008-2021		
NAICS	Industry	#	%	#	%	#	%	Change in Percentage
11	Agriculture, Forestry, Fishing, & Hunting	4	0.3	12	0.8	18	1.6	+ 433%
21	Mining	5	0.4	6	0.4	2	0.2	- 50%
22	Utilities	3	0.2	5	0.3	15	1.3	+ 550%
23	Construction	32	2.5	37	2.5	41	3.6	+44%
31-33	Manufacturing	912	71.6	809	55.4	422	36.8	- 49%
42	Wholesale Trade	23	1.8	14	1.0	6	0.5	- 72%
44-45	Retail Trade	15	1.2	48	3.3	65	5.7	+ 375%
48-49	Transportation & Warehousing	14	1.1	35	2.4	34	3.0	+ 173%
51	Information	6	0.5	11	0.8	8	0.7	+ 40%
52	Finance & Insurance	2	0.2	17	1.2	17	1.5	+ 650%
53	Real Estate & Rental & Leasing	2	0.2	11	0.8	7	0.6	+ 200%
54	Professional, Scientific & Technical Services	9	0.7	16	1.1	9	0.8	+14%
55	Management of Companies & Enterprises	0	—	1	0.1	1	0.1	N/A
56	Administrative & Support & Waste Management	10	0.8	27	1.8	59	5.1	+ 538%
61	Educational Services	40	3.1	73	5.0	59	5.1	+ 65%
62	Health Care & Social Assistance	105	8.2	194	13.3	185	16.1	+ 96%
71	Arts, Entertainment & Recreation	5	0.4	11	0.8	18	1.6	+ 300%
72	Accommodation & Food Services	19	1.5	49	3.4	59	5.1	+ 240%
81	Other Services (except Public Administration)	22	1.7	31	2.1	43	3.7	+118%
92	Public Administration	44	3.5	46	3.1	63	5.5	+ 57%
00	Unknown	2	0.2	8	0.5	16	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 509 (13.1%) of Michigan's WRA patients, and isocyanates (MDI, TDI, HDI and others) accounting for 454 (11.7%) of the WRA case exposures. Metal working fluids (coolants) accounted for 335 (8.6%) 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 in the form of 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 highlights 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 19.3% of all the WRA exposures in 1988-1997 to 7.1% in 2008-2021. Cleaning agents increased from 4.6% of all the WRA exposures in 1988-1997 to 20.6% in 2008-2021. Metalworking fluids, solvents, latex rubber, welding fume, epoxy, formaldehyde and acids also decreased over time, while there was an increase in cases reported from exposure to 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 1988-2021. 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.

Safety Data Sheets (SDS) can be used to identify ingredients in products that may cause asthma. However, a physician may have to write the company to find out about trade secret ingredients not specifically listed on the SDS.

TABLE 9
Top Workplace Exposures Associated with Confirmed WRA Patients: 1988-2021

Exposure Agent	#	%
Cleaning Solutions	509	13.1
Isocyanates	454	11.7
Metal Working Fluids	335	8.6
Unknown (Mfg.)	283	7.3
Unknown (Office)	211	5.4
Exhaust/Smoke/Fumes	178	4.6
Welding Fume-Stainless & Other	164	4.2
Solvents	116	3.0
Paint Fumes	94	2.4
Fungus	92	2.4
Epoxy	88	2.3
Acids	72	1.9
Fire	70	1.8
Formaldehyde	68	1.8
Latex/Rubber	64	1.6
Construction Exposures	59	1.5
Chlorine	55	1.4
Plastic Fumes	54	1.4
Animal Dander	47	1.2
Acrylates	39	1.0
Fragrances	37	1.0
Cobalt	34	0.9
Wood Dust	34	0.9
Flour	30	0.8
Ammonia	26	0.7
Styrene	23	0.6
Cigarette Smoke	23	0.6
Herbicide/Pesticide	22	0.6
Fiberglass	20	0.5
Aldehydes	19	0.5
Plants/Organic Matter	19	0.5
Cement Dust	17	0.4
Medication	17	0.4
Chromium	16	0.4
Amines	16	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
Heat	13	0.3
Metal Dust	12	0.3
Anhydrides	11	0.3
Insecticides	9	0.2
Meat Wrapper's Asthma	9	0.2
Sewage	9	0.2
Freon	8	0.2
Paper Dust	8	0.2
Other[a]	303	7.8
Total	**3,882**	

[a]There were 7 cases each with exposure to: Azodicarbonamide, Cold Air, Enzymes, Pepper Gas, Polyurethane.

There were 6 cases each with exposure to: Cooking Oil, Exercise, Nitrogen, Pickling Ingredients, Solder Fume, Sulfur Dioxide, Textile Lint.

There were 5 cases each with exposure to: 1,1,1 Trichloroethane, Coal Dust, Drywall 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.

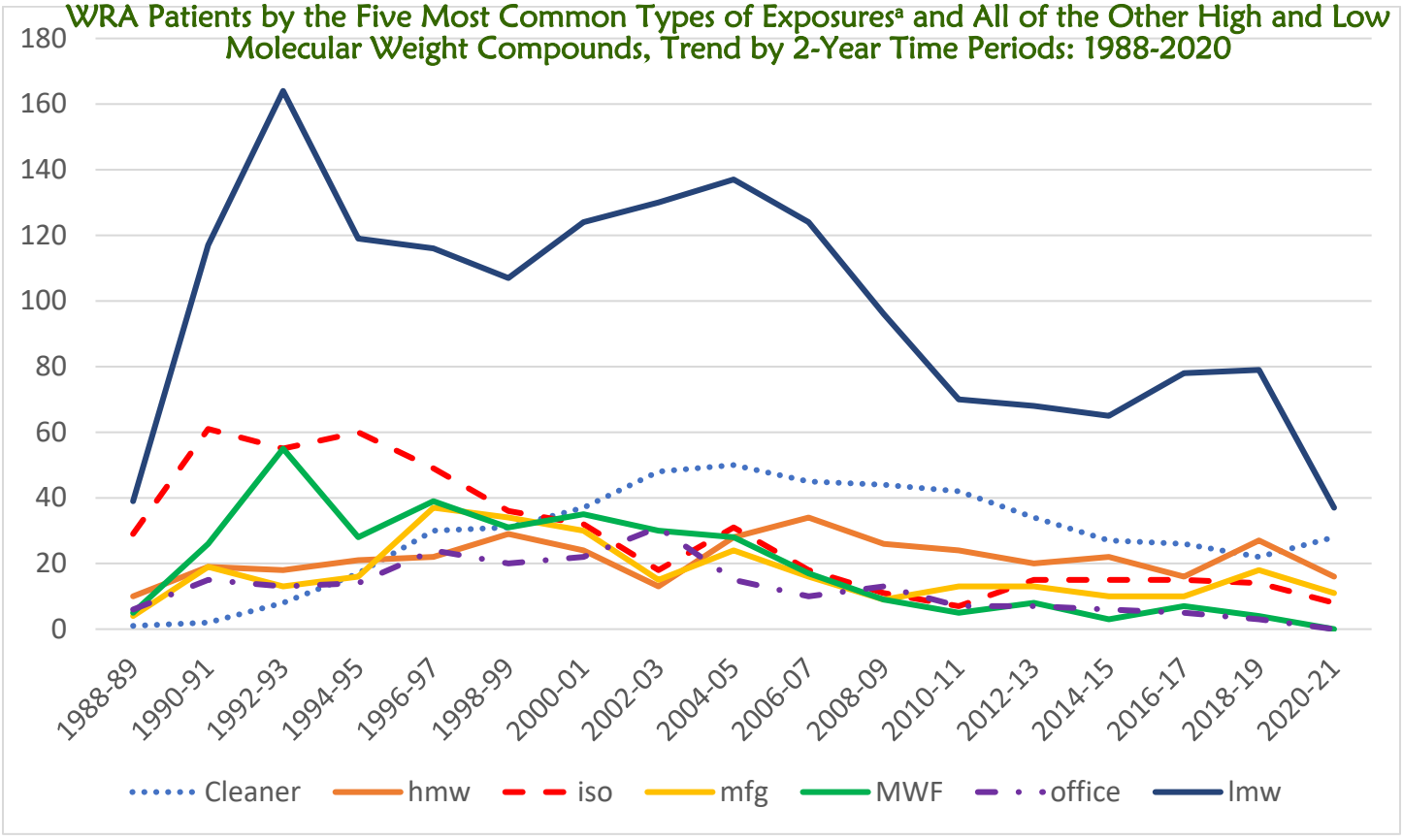
There were 2 cases each with exposure to: Ammonium Chloride, Barbeque Smoker, Bitrex, Calcium Chloride (used in Cherry Brine), Car Window Sealant, Carbon Dioxide, Cellulose, Concrete Sealer, Copper Oxide, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Glaze, Heated Polyvinyl Chloride, Isopropyl 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, 1,3 Dichloro, 1-bromo-3-chloro-5 5-Dimethyl Hydantoin, Agent Orange, Ammonium Bifluoride, Antifreeze, Auto Body Shop Chemicals, Benzoate Esters, Blood, Blue Prints, Calcium Carbonate, Carbon Monoxide, Catheter Demonstration Chemical, Ceramic Powder, Crude Oil, Cyanide, Deck Stain, Desert Storm, Dry Ice, Eggs, Ethylene Oxide, Face Mask, Flares, Gortex, Heated Vinyl, 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, Stress, Swimming Pool Shock, Tetrahydrofuran, Titanium Tetrachloride, Tuberculosis Vaccine, Urethane, Vaping Fumes, Vinegar, White Lithium, Wood Smoke, World Trade Center Exposure, Zinc Borate.

TABLE 10
Top Workplace Exposures of WRA Patients by Time Period

	Time Period				
	All Years	1988-1997	1998-2007	2008-2021	Change in Percentage
Exposure Type	# (%)	# (%)	# (%)	# (%)	
Cleaning Agents	509 (13.1)	59 (4.6)	214 (14.6)	236 (20.6)	+ 348%
Isocyanates	454 (11.7)	246 (19.3)	126 (8.6)	82 (7.1)	- 63%
Metalworking Fluids	335 (8.6)	153 (12.0)	144 (9.9)	38 (3.3)	- 73%
Welding Fume	164 (4.2)	63 (4.9)	62 (4.2)	39 (3.4)	- 31%
Solvents	116 (3.0)	51 (4.0)	52 (3.6)	13 (1.1)	- 73%
Paint	94 (2.4)	18 (1.4)	49 (3.4)	27 (2.4)	+ 71%
Epoxy	88 (2.3)	33 (2.6)	28 (1.9)	27 (2.4)	- 8%
Fungus	92 (2.4)	0	41 (2.8)	51 (4.4)	+ 57%
Formaldehyde	68 (1.8)	33 (2.6)	19 (1.3)	16 (1.4)	- 46%
Acids	72 (1.9)	27 (2.1)	24 (1.6)	21 (1.8)	- 14%
Latex/Rubber	64 (1.6)	25 (2.0)	33 (2.3)	6 (0.5)	- 75%

FIGURE 3
WRA Patients by the Five Most Common Types of Exposures[a] and All of the Other High and Low Molecular Weight Compounds, Trend by 2-Year Time Periods: 1988-2020



[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. This is very similar to the state average for 2021 (17.0%) (https://www.michigan.gov/mdhhs/-/media/Project/Websites/mdhhs/Keeping-Michigan-Healthy/Communicable-and-Chronic-Diseases/Epidemiology-Services/2021_MiBRFS_Annual_Report.pdf?rev=6731456db33f4d8d8f06ca0443eee113&hash=153E17E410E9D951CB62B9393A2D92A6).

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.

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-four 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 5.4 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 no WRA deaths reported in 2020. 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 who 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. In addition, we have published articles on some of the work-related asthma deaths[4,5].

TABLE 11
Cigarette Smoking Status of 3,726[a]
Confirmed WRA Patients: 1988-2021

	Smoking Status						
	Current		Ex-Smoker		Non-Smoker		TOTAL
	#	%	#	%	#	%	
OA	250	20.6	462	38.1	501	41.3	1,213
POA	201	15.3	527	40.1	585	44.6	1,313
AA	166	21.0	198	25.0	427	54.0	791

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%, and a decrease to 17% in 2021.

TABLE 12
Cigarette Smoking Status of WRA Patients by Time Period

	Time Period				
	All Years	1988-1997	1998-2007	2008-2021	Change in Percentage
Smoking Status	# (%)	# (%)	# (%)	# (%)	
Current	728 (20)	243 (20)	295 (21)	190 (18)	- 10%
Ex-Smoker	1,339 (36)	540 (43)	479 (34)	320 (30)	- 30%
Non-Smoker	1,659 (45)	463 (37)	632 (45)	564 (53)	+ 43%
Total	3,726[a]	1,246	1,406	1,071	

[a]Missing data on 156 patients.

TABLE 13
Personal History of Allergies or Asthma Among 3,503[a] Confirmed WRA Patients: 1988-2021

Personal History of...

	Allergies & Asthma		Asthma Only		Allergies Only		No Allergies or Asthma	
	#	%	#	%	#	%	#	%
OA	67	5.9	59	5.2	342	30.0	674	59.0
POA	93	7.7	63	5.2	420	34.6	638	52.6
AA	407	51.1	350	44.0	19	2.4	20	2.5
RADS	19	5.4	36	10.3	86	24.5	210	59.8
All	586	16.7	508	14.5	867	24.8	1,542	44.0

[a]Missing data on 379 patients.

TABLE 14
Health Care Usage Among Confirmed WRA Patients: 1988-2021

Lifetime History of Health Care Usage

ED Visit[a]		Hospitalized[b]	
Yes # (%)	No # (%)	Yes # (%)	No # (%)
2,428 (67)	1,216 (33)	1,183 (34)	2,254 (66)
Range 1-300 visits		Range 1-200 hospitalizations	
AVG 5.3 ±14.5		AVG 3.6±9.7	

[a]Missing data on 238 patients.
[b]Missing data on 445 patients.

SYMPTOMS

Two thousand nine hundred seventy-nine (2,979) 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: Seventy-five to 90% 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 2008-2021, 23% of those still exposed reported an improvement in symptoms, compared to 43% 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 14% reporting the need for less asthma medication during 2008-2021, compared to 31% among those no longer exposed.

TABLE 15
Persistence of Symptoms and Medication Use in 3,439 Confirmed WRA Patients: 1988-2021

Still Exposed?	Total	Breathing Problems Still Present?				Still Taking Asthma Medications?			
		Yes		Less		Yes		Less	
		#	%	#	%	#	%	#	%
Yes	993	931	95.0	286	28.8	865	87.1	172	17.3
No	2,446	2,036	83.2	1,143	46.7	1,912	78.2	702	28.7
Total	3,439[a]	2,979		1,429		2,777		874	

[a]Information missing on 443 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	
2008-2021	Yes	265	241	90.9	61	23.0	241	90.9	35	13.6
	No	671	503	75.0	289	43.1	519	77.3	205	30.6
	Total	963	744		350		760		241	
Change in Percentage	Yes			-6%		-33%		+7%		-36%
	No			-9%		-13%		+4%		+4%

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	2008-2021	Change in Percentage
Test Type	(%)	(%)	(%)	(%)	
Pre-post Bronchodilatation	49	54	54	36	- 33%
Methacholine Challenge	17	25	16	8	- 68%
Peak Flow at Work & Home	3	3	3	4	[a]
Pre-post Work-shift	3	2	4	2	[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, 39% were awarded, 17% were denied and 43% were pending approval.

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 and 2008-2021. The first two time periods showed 49% of patients applying for workers' compensation benefits, and the third period had 51% 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 51% in the most recent time period. The percentage of claims denied also increased over the time periods, from 16% to 17% to 20% in the most recent time period. Accordingly, the percentage of claims pending approval decreased from 48% to 50% to 29% in the most recent time period.

INDUSTRIAL HYGIENE

A total of 820 workplace inspections have been conducted since 1988 (Table 18); 123 of those facilities had been inspected more than once. There were no inspections in 2020 and only inspection in 2021 due to the COVID-19 pandemic.

Air sampling was conducted during 585 inspections (Table 19); 31 (5.4%) of the 578 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: 1988-2021

	# Patients	Companies	
Inspection Status	Represented	#	%
Inspected	1,280	820[a]	29.8
No Follow-up Planned	2,319	1,727	62.7
Scheduled for Inspection	14	14	0.5
Out of Business	78	70	2.5
No Longer Use Occupational Allergen	27	26[b]	0.9
Sent Company Letter to Check Exposures[d]	103	96	3.5
Total	3,821	2,753[c]	

[a]820 inspections were conducted in 697 different workplaces.
[b]Eight companies that no longer use the suspected causal agent were previously inspected.
[c]Represents 2,630 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 819 Workplace Inspections: 1988-2021

Air Sampling – NIOSH Standard	#	%
Above NIOSH Standard	69	8.4
Below NIOSH Standard	485	59.1
No NIOSH Standard	33	4.0
Unknown (no report yet)	4	0.5
Did Not Sample for an Allergen	31	3.8
Did Not Sample	198	24.1
Total	820	
Air Sampling – MIOSHA Standard	#	%
Above MIOSHA Standard	31	3.8
Below MIOSHA Standard	547	66.7
No MIOSHA Standard	7	0.9
Unknown (no report yet)	4	0.5
Did Not Sample for an Allergen	33	3.8
Did Not Sample	198	24.1
Total	820	

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 1988-2021

	Above NIOSH REL		Above MIOSHA PEL	
Asthma-Causing Agents	#	%	#	%
Formaldehyde	28	41.8	1	3.3
Cobalt	8	11.9	6	20.0
Styrene	6	9.0	4	13.3
Metal-Working Fluids	5	7.5	1	3.3
Glutaraldehyde	4	6.0	3	10.0
HDI	4	6.0	No PEL	--
MDI	3	4.5	0	--
Wood Dust	3	4.5	2	6.7
Chromic Acid	1	1.5	1	3.3
Ethylene Oxide	1	1.5	0	--
Phthalic Anhydride	1	1.5	1	3.3
Starch	1	1.5	0	--
Total Dust (Dry Plant Materials)	1	1.5	0	--
Total Dust (Grinding on Fiberglass)	1	1.5	1	3.3
Welding Fume (Total Particulate)	No REL	--	8	26.7
Flour Dust	No REL	--	2	6.7
TOTAL	67	100.2[a]	30	99.9[a]

[a]Percentages do not add to 100 due to rounding.

Co-Worker Interviews at Workplace Investigations – Trends

Co-workers were interviewed during 623 of the 819 inspections. Workers had daily or weekly breathing symptoms associated with work or new onset asthma since beginning to work at 403 of the 623 (65%) companies. The average percentage of co-workers with symptoms in these 403 companies was 20.4%. All 1,701 co-workers from the remaining 220 companies reported no daily or weekly breathing symptoms associated with work. One thousand six hundred thirty-five (1,635) of the 10,558 (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.

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 819 MIOSHA enforcement inspections.

TABLE 21
Breathing Symptoms Among Co-Workers of the 3,820 Confirmed WRA Patients: 1988-2021 and by Time Period

	# Workers Interviewed	Daily or Weekly SOB, Wheezing or Chest Tightness	%
	10,558	1,635	15.5
BY TIME PERIOD:			
1988-1997	6,293	1,125	17.9
1998-2007	3,200	380	11.9
2008-2021	1,065	130	12.2
Workers on OSHA Log		586	
	# Companies Inspected	# Companies w/Employee on Log	%
	819	137	16.7
BY TIME PERIOD:			
1988-1997	437	76	17.4
1998-2007	266	52	19.5
2008-2021	116	9	7.8
Total Workers with Symptoms[a]		2,221	

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

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 under-counts non-manufacturing-exposed employees such as at auto body paint shops because the EPA does not include non-manufacturing establishments. Conversely, our estimate over-counts 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 source to identify chemical exposures associated with WRA comes from 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. Data can only be requested one at a time for each individual company.***

In the EPA TRI, there were 79 companies that reported using isocyanates in 2021, which is less than the 95 companies reported in 2020. In 2019, there were 104 companies, 106 companies in 2018 and 112 companies that reported using isocyanates in 2017. There were 111 companies in 2016 and 112 companies in 2015 reporting isocyanate use. 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 is listed in Table 22. In 2021, there were 24,020 workers potentially exposed to isocyanates, which is an approximate decrease of 6,000 workers in 2020. There were 29,894 workers in 2020 and 45,298 workers potentially exposed to isocyanates in 2019. In 2018 there were 45,458 workers, and in 2017 there were 44,739 workers potentially exposed to isocyanates.

TABLE 22 Michigan Workers Employed in Manufacturing Facilities in 2021 Where Isocyanates are Used, by County

County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
ALLEGAN	MOTUS INTEGRATED TECHNOLOGIES—MAPLEWOOD PARKER HANNIFIN HPD YAN FENG AUTOMOTIVE INTERIORS PMSC	606	57,710	**1.1**
BARRY	BRADFORD WHITE CORP	900	29,033	**3.1**
BAY	QUANTUM COMPOSITES INC	14	45,009	**<0.1**
BERRIEN	LECO CORP NILES STEEL TANK	51	66,476	**0.1**
BRANCH	GOKOH COLDWATER INC	15	18,148	**0.1**
CALHOUN	BREMBO HOMER FOUNDRY COMCAST URETHANE TRANSCONTINENTAL	668	59,943	**1.1**
CLARE	LEAR CORP. FARWELL PLANT	278	10,440	**2.7**

Table 22. County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
CRAWFORD	WEYERHAEUSER	200	5,070	**3.9**
DICKINSON	GREDE, LLC IRON MOUNTAIN LOUISIANA-PACIFIC-SAGOLA OSB	725	11,347	**6.4**
EATON	ALLIANCE INTERIORSSIKAAXON US	60	51,803	**0.1**
GENESEE	LANDAAL PACKAGING SYSTEMS	234	159,859	**0.1**
HILLSDALE	ESSEX SPECIALTY PRODUCTS	5	18,261	**<0.1**
HURON	VALLEY ENTERPRISES	11	14,231	**0.1**
INGHAM	HUNTSMAN ADVANCED MATERIALS SA AUTOMOTIVE	395	136,006	**0.3**
ISABELLA	THE DELFIELD CO. UNIFIED BRANDS	1,500	30,354	**4.9**
JACKSON	MILSCO MICHIGAN SEAT TAC MFG	1,485	67,407	**2.2**
KALAMAZOO	AZON USA FLOWSERVE CORP STRYKER INSTRUMENTS	4,268	122,130	**3.5**
KENT	CLIPPER BELT LACING CO, DBA FLEXCO INC FLEXIBLE STEEL LACING CO, DBA FLEXCO GRAND RAPIDS FOAM TECHNOLOGIES HB FULLER KENDRICK PLASTICS LACKS WHEEL TRIM SYSTEMS, BARDEN PLATER	830	330,032	**0.3**
LENAWEE	ANDERSON DEVELOPMENT INTEVA PRODUCTS	621	41,492	**1.5**
LIVINGSTON	ANTOLIN-HOWELL	718	90,819	**0.8**
LUCE	LOUISIANA-PACIFIC CORP-NEWBERRY SIDING	126	2,063	**6.1**
MACOMB	AXALTA COATING SYSTEMS FCA US ASSEMBLY PLANT INTERNATIONAL CASTING CORP MAYCO INTERNATIONAL MOON ROOF CORP OF MI ROMEO RIM INC SHELBY FOAM SYSTEM WOLVERINE BRONZE	2,831	386,942	**0.7**
MASON	GREAT LAKES CASTING	160	12,142	**1.3**
MIDLAND	DDP SPECIALTY ELECTRONIC PARTS LLC	722	36,742	**2.0**
MONROE	SUNRISE WINDOWS LTD	275	67,764	**0.4**
MONTCALM	KENT FOUNDRY MARVEL REFRIGERATION	260	25,578	**1.0**
MUSKEGON	MUSKEGON COMPOSITES, INC	62	68,681	**0.1**
OAKLAND	ARMALY SPONGE EAGLE INDUSTRIES LYMTAL INTERNATIONAL INC RECTICEL UREPP N AMERICA	169	588,572	**<0.8**

Table 22. County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
OTTAWA	MAGNA ENGINEERED GLASS ROYAL TECH	2,022	148,077	**1.4**
SAGINAW	GLASTENDER POREX TECHNOLOGIES SAGINAW METAL CASTING OPERATIONS	919	76,397	**1.2**
SANILAC	ASCO LP GRUPO ANTOLIN MIDWEST RUBBER CO	815	17,641	**4.6**
ST CLAIR	AURIA SOLUTIONS ST CLAIR (IAC) IAC PORT HURON	201	65,042	**0.3**
ST JOSEPH	FOREST RIVER INC	400	26,418	**1.5**
VAN BUREN	MASTER BUILDERS SOLUTIONS CONST. SYSTEMS SPECIAL-LITE INC	170	31,932	**0.5**
WAYNE	BASF CORP—LIVONIA PLANT BASF CORP—WYANDOTTE PLANT CYGNET AUTOMATED CLEANING EQ DETROIT FCA DETROIT ASSEMBLY COMPLEX FCA US JEFFERSON NORTH ASSEMBLY PLANT WEBASTO ROOF & COMPONENTS WINDSOR MACHINE & STAMPING (US) LTD	824	686,888	**0.1**
WEXFORD	REC BOAT HOLDINGS-CRUISER PLANT REC BOAT HOLDINGS-SPORT/ENGINEERING TJS WAREHOUSE	480	13,402	**3.6**
TOTAL		**24,020**	**3,619,851**	**0.7**

[a]Source: Manta.com, accessed 11/24/2021 and D&B Hoovers accessed 5/31/2023.

[b]Source: Michigan Labor Market Information, Data Explorer, www.milmi.org accessed 11/24/2021.

[c]Source: U.S. Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2021, data accessed 4/20/2023.

Table 23 summarizes the companies, by county, using 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 calendar year 2021.

Additional chemical exposures associated with WRA in Michigan can be found in a 2020 report at: https://oem.msu.edu/images/resources/WRAsthma/2020_MI_Workforce_Exposed_to_Select_Asthma-Causing_Agents.pdf

TABLE 23
Michigan Facilities by County, Reporting to the United States Environmental Protection Agency (EPA) Toxic Release Inventory (TRI) in 2021[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	BAY CAST - CENTER STREET PLANT	CO
	BAY CAST - WEBSTER STREET PLANT	CO
	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
	NCP COATINGS LLC	P
BRANCH	HC STARCK INC.	A, CO
	REAL ALLOY RECYCLING LLC	CH
	REAL ALLOY SPECIFICATION LLC	CH
	STAR OF THE WEST MILLING CO.	CH
CALHOUN	AVIENT COLORANTS USA LLC - ALBION FACILITY	CO
	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
CHARLEVOIX	ST MARYS CEMENT U.S. LLC	A
CLINTON	MWC LLC.	A
CRAWFORD	ARAUCO NA GRAYLING PARTICLEBOARD	F
	GEORGIA-PACIFIC CHEMICALS LLC	A, F
DELTA	VERSO ESCANABA LLC.	A, CH, F

COUNTY	COMPANY NAME	EXPOSURES
DICKINSON	LOUISIANA-PACIFIC SAGOLA OSB	F
	VERSO QUINNESEC	A, CH, F
EATON	ETM ENTERPRISES INC.	S
	SIKA ADVANCED RESINS US	S
GENESEE	WOODWORTH INC FLINT	A
GRATIOT	AGROLIQUID - ASHLEY	A
HOUGHTON	CALUMET ELECTRONICS CORP.	A
	CALUMET ELECTRONICS CORP.	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
	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
	HAVILAND PRODUCTS CO.	F
	PHARMACIA & UPJOHN CO LLC A SUBSIDIARY OF PFIZER INC.	A, CH, E, F
	RICHARD-ALLAN SCIENTIFIC	F
KENT	ARKEMA INC.	P, S
	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
	NBHX TRIM CORP.	S
	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
	VALERO RENEWABLE FUELS CO LLC	F
	WACKER CHEMICAL CORP	A
LIVINGSTON	PROGRESSIVE METAL FORMING INC.	CO
	WYMAN-GORDON CO.	CO

COUNTY	COMPANY NAME	EXPOSURES
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
	METALLURGICAL PROCESSING CO.	A
	SPECIALTY STEEL TREATING INC..	A
MANISTEE	PACKAGING CORP OF AMERICA	F
MARQUETTE	DYNO NOBEL INC	A
	EAGLE MINE	CO
	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
	SK SARAN AMERICAS LLC	M
	THE DOW CHEMICAL CO.1790 BUILDING	A, CH, F, M, 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
	BASF CORP.	A
	CANNON-MUSKEGON	CO
	HOWMET CORP - PLANTS 1& 3	CO
	HOWMET CORP-PLANT 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, F
	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
	GENTEX CORP AUTOMOTIVE DIV.	M

COUNTY	COMPANY NAME	EXPOSURES
	J H CAMPBELL GENERATING PLANT	A
	REQUEST FOODS INC.	A
	VERTELLUS ZEELAND LLC	A
	VERTELLUS ZEELAND LLC	MA
SAGINAW	ADVANCED MICRONUTRIENT PRODUCTS INC	A
	STAR OF THE WEST MILLING CO.	CH
SANILAC	DGP INC.	S
	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
	POET BIOREFINING-CARO LLC	F
VAN BUREN	ALLOY STEEL TREATING CO. INC.	A
WASHTENAW	DAPCO INDUSTRIES	A
	THETFORD CORP.	F
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.	MA, S
	FRITZ PRODUCTS	CH
	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
	REPUBLIC INDUSTRIAL & ENERGY SOLUTIONS LLC.	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 2021, accessed 4/20/2023.

Discussion

The risk for WRA from exposure to cleaning agents increased with the onset of the COVID-19 pandemic, especially following the adoption of recommendations for increased use of disinfectants. Conversely, presumably the risk of WRA from other workplace exposures commonly found in manufacturing or construction or from office work settings would have decreased in association with the initial stay-at-home order for all but essential workers. The large number of office workers who have continued to telecommute would also presumably continue to reduce the risk of WRA among those workers. Among the 46 WRA cases identified in 2020, 30% (14/46) were associated with exposures to cleaners and disinfectants; normally cleaning agents constitute 13% of all the MI WRA cases. In 2021, 21% (13/62) of cases were identified with exposures to cleaners and disinfectants.

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 in 15% of adults with asthma, the asthma is caused by work exposures.[6] A second ATS consensus statement estimated 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.

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 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 concerns of their patients and probably missing the identification of WRA triggers. Because of the frequency in 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."[8]

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.[9]

In 2020, we reviewed the Michigan work-related asthma surveillance system from 1988 -2018.[10] 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 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. 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%.

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 their 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.[11] Table 24 shows the characteristics of Michigan adults with asthma attributable to work, based on a telephone survey. These characteristics are similar to that found in the cases of WRA identified through our surveillance system.

Workers who are reported are generally young to middle-age Caucasian men and women, with the greatest number being reported from the Detroit metropolitan area. However, the rate of WRA in African Americans is 2.2 times greater than among Caucasians. Based on an analysis conducted for previous annual reports, factors from the WRA surveillance data that would contribute to greater morbidity among African Americans include: a greater likelihood to continue 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 (13.1%), isocyanates (11.7%) and metal working fluids (8.6%). 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%, 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% ($P < .001$). [12] 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.[13] 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	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 6.4% of the workforce is potentially exposed to isocyanates, and in Luce county approximately 6.1% of the workforce is exposed. In Isabella, 4.9% and in Sanilac, 4.6% of the workforce is 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://michiganegle.govqa.us/WEBAPP/_rs/(S(klbft04zm5cfvqjwxgy50ofn))/SupportHome.aspx?sSessionID=.

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.[8] On the average, among the 2,446 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 State and only 3% by the employer.[14] 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 personal or family history of allergies do not predict who will develop WRA. About 44% 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 were no WRA inspections in 2020 and only one inspection in 2021 due to 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 indicate they have 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.[8] A review of companies using isocyanates showed that only 32% were providing periodic medical surveillance.[15]

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.[8] 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.

In July 2020, we 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 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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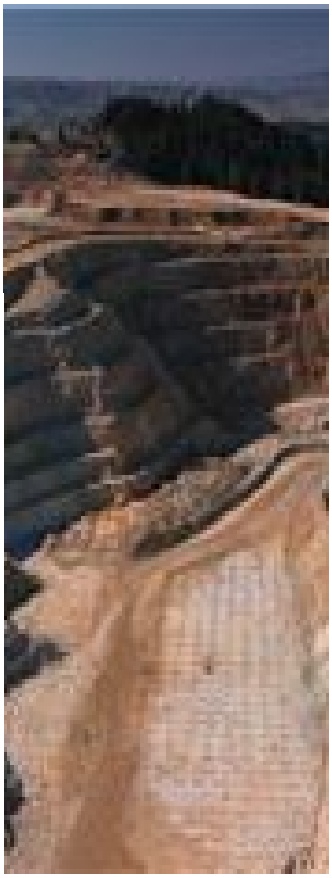
APPENDIX

2021 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

OA4440 A male in his 40s developed work-related asthma from exposure to isocyanates at an automotive parts manufacturer where he was a maintenance man. He was a current smoker.

OA4419 A female in her 30s developed work-related asthma from exposure to isocyanates at an automotive parts manufacturer where she worked as a job setter. Her asthma began when a hose blew that was supplying the isocyanates to the tank used each day for the machines. She immediately experienced shortness of breath and was prescribed Symbicort and Albuterol in the emergency department. She was a current smoker, smoking one cigarette per day since her 20s. She continued to work at this job after her diagnosis.

OA4367 A male in his 50s developed occupational asthma from exposure to isocyanates while working at a glue manufacturer. He was an industrial maintenance worker whose job was to repair and maintain the machines. Since the first month he worked at the facility taking apart the pumps that make the glue, he developed wheezing, cough, chest tightness and shortness of breath. He was prescribed ProAir and Prednisone at the emergency department. He was fired after working there for a year and was not able to find new employment. His asthma has worsened although he requires less asthma medication. He was a current smoker, smoking half a pack of cigarettes a day since his teens.

Exposure to epoxies and glues

POA4439 An assembly line worker in her 50s developed work-related asthma after being exposed to hot glue. She developed a cough, chest tightness and shortness of breath. She was prescribed Albuterol and Advair in the emergency department. She formerly smoked a pack of cigarettes a day from her 20s to her 50s.

AA4400 A female in her 20s experienced an exacerbation of her pre-existing asthma from exposure to sprayed adhesive cleaners and degreasers at her job at an auto parts manufacturer. She experienced wheezing and shortness of breath. She was prescribed DuoNeb at the emergency department. She was a current smoker.

Exposure to plastic fumes

AA4354 AA female in her 30s experienced an exacerbation of her pre-existing asthma from exposure to burning plastic at an auto parts manufacturer where she was a machine operator. She experienced wheezing and shortness of breath. These symptoms worsened during her shift, were worse on Mondays or her first day back to work and worsened throughout the work week. She was prescribed Advair and Spiriva. She quit this job after working there for five years. She subsequently found a new job. Since leaving the auto parts manufacturing job, her asthma improved although she requires a greater amount of asthma medication. She was a life-long non-smoker.

AA4355 A female in her late teens experienced an exacerbation of her pre-existing asthma from exposure to plastic fumes working as a machine operator at plastic mold injection manufacturing facility. She experienced wheezing and shortness of breath. She was prescribed an inhaler and steroids at the emergency department. She continues to work at the facility, and her asthma has worsened, and she requires a greater amount of asthma medication. She was a life-long non-smoker.

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

OA4428 A female in her 30s developed work-related asthma from exposure to flour at a manufacturing bakery. Her job was to mix batches of flour with other dry ingredients. She developed a cough and shortness of breath. She was treated once in the emergency department. Since her diagnosis, she switched to a new job, and she no longer requires asthma medication.

AA4409 A female in her 20s experienced an exacerbation of her pre-existing asthma from exposure to multiple types of medication dust at her packaging job at a pharmaceutical manufacturer. Exposure to the dust triggered a cough, chest tightness, shortness of breath and wheezing. She quit this job upon her doctor’s advice and found new employment. Since then, her asthma improved. She was a life-long non-smoker.

OA4373 A female in her 20s developed occupational asthma from exposure to spices as line worker at a baked goods manufacturing facility. Her asthma developed when the company switched to a new spice line where spices were packaged. She experienced chest tightness and shortness of breath and was prescribed a rescue inhaler in the emergency department. She quit this job and found new employment. Since then, her asthma has improved, and she requires less asthma medication. She formerly smoked 15 cigarettes per day for 10 years from her mid-teens to mid-20s.

POA4385 A female in her 20s developed work-related asthma from exposure to lime while working at a sugar manufacturing facility. She developed a cough and shortness of breath and was prescribed Ventolin and Flovent in the emergency department. She is a current smoker, smoking half a pack of cigarettes a day since her mid-20s.

Exposure to miscellaneous chemicals and dusts

AA4442 An auto worker in her 50s experienced an exacerbation of her pre-existing asthma from exposure to large amounts of dust and debris. She experienced wheezing, a cough and shortness of breath. She was treated in the emergency department. She was a life-long non-smoker.

AA4408 A line worker in her 20s experienced an exacerbation of her pre-existing asthma at the auto manufacturing facility where she was exposed to dust. She was prescribed Symbicort, Singulair, Qvar, and an increased dose of Albuterol. She was treated in the emergency department five times. Since the exacerbation her asthma has worsened, and she requires a greater amount of asthma medication. She is a life-long non-smoker.

POA4432 A female in her 40s developed work-related asthma from exposure to metal finishing chemicals at a metal manufacturer. She worked close to the tanks of chemicals used to finish the metals. She developed shortness of breath and was prescribed ProAir and steroids in the emergency department. She formerly smoked cigarettes for less than a year in her teens. Since her diagnosis, her asthma has worsened. She has continued to work at the facility since her asthma diagnosis.

AA4421 A female in her 40s experienced an exacerbation of her pre-existing asthma from working in a dusty environment at an automotive manufacturing facility. The dust triggered her cough. She was treated in the emergency department and prescribed Albuterol and Dexamethasone. She was a life-long non-smoker.

AA4396 A male in his 20s experienced an exacerbation of his childhood asthma from exposure to a spill of tungsten carbide dust at the carbide tool manufacturing plant where he worked packaging the carbide powder. He immediately experienced wheezing, a cough, chest tightness and shortness of breath. He was treated in the emergency department. He formerly smoked a cigarette a day from his late teens to his early 20s.

POA4418 A female developed work-related asthma in her 20s from exposure to gas and exhaust fumes at the auto manufacturing plant where she worked filling the gas tanks for the cars going to dealerships. All day, she pumped gas and inspected the vehicles for road tests where they would start the cars next to her and accelerate the vehicle on the track. She developed a cough, wheezing, chest tightness and shortness of breath. She was prescribed Xopenex, Singulair and Advair. She was reassigned to a new department almost

20 years after her diagnosis. Over time, her asthma has worsened, and she requires a greater amount of asthma medication. She sought treatment at the emergency department three times. She was a life-long non-smoker.

AA4380 A male in his 20s experienced an exacerbation of his childhood asthma while working at a garment factory. He was exposed to heat and dust in the warehouse where he worked as a packager, organizing clothing for packaging and shipment. He was hospitalized, and prescribed Prednisone. He was fired from this job because his employer said his asthma would make him an unreliable employee. One month after his hospitalization he had not found new employment. Since his hospitalization, his asthma has worsened, and he requires a greater amount of asthma medication. He was a life-long non-smoker.

Miscellaneous

AA4383 A female in her 20s experienced an exacerbation of her pre-existing asthma from heat exposure at the automotive manufacturer where she worked as a mechanic technician. She experienced a cough, chest tightness and shortness of breath. She was prescribed two inhalers at the emergency department. She was fired the day she was treated at the hospital. Since then, she requires a greater amount of asthma medication. She was a life-long non-smoker.

AA4381 A female in her 30s experienced an exacerbation of her pre-existing asthma from excessive heat exposure at the auto parts manufacturer where she worked as a press operator. She experienced wheezing and shortness of breath and was prescribed Advair in the emergency department. Her asthma exacerbations would worsen during the shift when she worked and were worse on Mondays or her first day back to work. Since working at the facility, her asthma has worsened, and she requires a greater amount of asthma medication. She was a life-long non-smoker.

AA4370 A female in her 30s experienced an exacerbation of her pre-existing asthma while working at an auto parts manufacturer. She experienced chest tightness and shortness of breath and was prescribed Prednisone at the emergency department. Since this exacerbation she requires a greater amount of asthma medication. She was a current smoker, smoking two cigarettes per day.

POA4352 A male in his 50s developed work-related asthma while working for a company that manufactured custom compounds for industrial use. He experienced wheezing and shortness of breath and was prescribed DuoNeb, Albuterol and Solumedrol in the emergency department. He was a life-long non-smoker.

EDUCATIONAL SERVICES

Exposure to air contaminants

AA4379 A female in her 50s who worked as a music teacher at an elementary school experienced an exacerbation of her pre-existing asthma from exposure to aerosolized hand sanitizer contaminated with latex. Usually, a co-worker sprayed the students' hands, but she performed this activity one day. She was allergic to latex; workers who manufacture hand sanitizer wear latex gloves when making the hand sanitizer, which then becomes contaminated with latex. She experienced chest tightness and shortness of breath, had an anaphylactic reaction and passed out. She was taken by EMS to the emergency department. She continued to work at the elementary school and avoided any potential exposure to latex. She was a life-long non-smoker.

HEALTH CARE SERVICES

Exposure to COVID

AA4414 A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to the COVID-19 virus at the hospital where she worked as a certified nursing assistant. She was working in the COVID Unit. She experienced a cough, wheezing, chest tightness and shortness of breath. She was treated in the emergency department and prescribed Spiriva, Advair and an Albuterol rescue inhaler. She wore an N95 mask and a full Tyvek suit at work. Since the exacerbation, her asthma has worsened, and she requires a greater amount of asthma medication. She formerly smoked a half a pack a day of cigarettes for almost 20 years.

POA4377 A female in her 50s developed work-related asthma while providing health care to prisoners. She developed COVID-19 and experienced long-haul COVID. She experienced chest tightness and shortness of breath. She was prescribed Albuterol, DuoNeb, Wixela, Fluticasone and Solumedrol. Her asthma has worsened, and she requires a greater amount of asthma medication.

Exposure to disinfectants

AA4397 A female in her 20s experienced an exacerbation of her childhood asthma from exposure to the mixing of toilet bowl cleaner and bleach when she was performing cleaning activities at a group home. She immediately experienced a cough and shortness of breath. She was treated with steroids, a bronchodilator and Albuterol in the emergency department. She was a life-long non-smoker.

RADS4393 A female in her 60s developed RADS from an acute exposure to a disinfectant fogger and a smell neutralizer spray that was being used to disinfect at a hospital reception area. The receptionist was in the bathroom when the fogging and cleaning was being performed by the janitor, who was not aware that she was still in the building. She immediately experienced a cough and shortness of breath. She was prescribed Combivent in the emergency department. She was reassigned to a new work location and does

not work when any cleaning is being performed. Since the development of her asthma, her symptoms have improved although she requires a greater amount of asthma medication. She was a life-long non-smoker.

Exposure to other cleaning products

AA4376 A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to cleaners at the nursing home where she worked as a health aide, caring for and bathing patients. She experienced wheezing and shortness of breath and was prescribed Prednisone in the emergency department. She continued to work at this job.

Exposure to indoor air contaminants and miscellaneous chemicals and dust

AA 4415 An activity therapist in her 50s experienced an exacerbation of her pre-existing asthma when she was exposed to pepper spray when it was being used at a psychiatric ward by a co-worker to subdue a patient. She developed wheezing and shortness of breath. She was prescribed Solu-Medrol, Prednisone and a Breo inhaler in the emergency department. Since the incident her asthma has improved. She was a life-long non-smoker.

AA4406 A male in his 30s experienced an exacerbation of his pre-existing asthma from working in a dusty environment at a pharmacy warehouse. He experienced wheezing and chest tightness and was prescribed steroids and Albuterol in the emergency department. He was a life-long non-smoker.

AA4435 A male in his 30s experienced an exacerbation of his pre-existing asthma from exposure to smoke from a fire at the hospital where he worked as a pharmacist. He immediately experienced a cough, chest tightness and shortness of breath. In the emergency department he was prescribed Albuterol, Qvar and DuoNeb. He was a life-long non-smoker.

AA4405 A female in her 30s experienced an exacerbation of her pre-existing asthma from exposure to pollen from flowers and cigarette smoke fumes at the hospital where she was a pharmacy technician. She experienced a cough, shortness of breath, chest tightness and wheezing. These asthma symptoms became worse over her work shift and improved when she was away from work on weekends or vacations. She was a life-long non-smoker.

AGRICULTURE

Exposure to miscellaneous substances

AA4422 A farmworker in her 20s experienced an exacerbation of her pre-existing asthma when she was baling hay. She was prescribed Albuterol and Prednisone in the emergency department. Since the exposure her asthma has improved, and she requires less asthma medication.

AA4425 A male in his 40s experienced an exacerbation of his pre-existing asthma from exposure to something in the greenhouse where he worked. He experienced wheezing and shortness of breath. He was treated in the emergency department. He was a life-long non-smoker.

AA4424 A male in his teens experienced an exacerbation of his childhood asthma from exposure to mixing cleaning chemicals while working at a farm. The chemicals he was mixing were to clean out a stall, which he did for almost two hours. Within 24 hours of the exposure, he developed a cough and was prescribed an inhaler and a nebulizer in the emergency department. He was a life-long non-smoker.

WHOLESALE AND RETAIL SERVICES

Exposure to cleaning agents

AA4388 A male in his 60s experienced an exacerbation of his pre-existing asthma when he was exposed to floor stripper and floor wax. He was a stocking manager at a supermarket. He experienced shortness of breath and was prescribed Advair, Flonase and Albuterol in the emergency department. After this exposure he developed COVID and subsequently quit his job. His asthma has worsened, and he requires a greater amount of asthma medication. He was a life-long non-smoker.

Exposure to miscellaneous chemicals and dust

OA4429 A female developed work-related asthma in her 20s from exposure to moldy vegetables at a vegetable produce farm where she worked in sales and food safety. She had worked for about four years before she developed a cough, chest tightness and shortness of breath. Her asthma worsened during her work shifts, was worse on first days back to work, and worsened throughout the work week. She was prescribed Prednisone, Symbicort and Albuterol in the emergency department. She eventually quit this job due to her asthma. Since then, her asthma has improved. She was a life-long non-smoker.

POA4369 A male in his 60s developed work-related asthma from exposure to wood dust at the lumber and building supply store where he worked as a lumber department associate. He experienced a cough and shortness of breath and was prescribed Prednisone at the emergency department. He continues to work at the store despite his asthma worsening. He smoked a pack of cigarettes a day for two years in his late teens.

AA4360 A male in his 20s experienced an exacerbation of his pre-existing asthma while working as a forklift operator at a magazine and newspaper distribution center. Shortly before he was hired, there was a fire in the building's insulation. He experienced shortness of breath, which worsened throughout his shift and improved when away from work on weekends or vacations. He continued to work at the facility. His asthma has worsened, and he requires a greater amount of asthma medication. He was a life-long non-smoker.

CONSTRUCTION

Exposure to miscellaneous chemicals and dust

AA4427 A male in his 60s experienced an exacerbation of his childhood asthma from exposure to dusts from sanding Corian fabricated countertops. He experienced shortness of breath and was prescribed Albuterol, a nebulizer and Advair in the emergency department. Since the exacerbation, his asthma has worsened, and he requires a greater amount of asthma medication. He was also diagnosed with COPD. He was a current smoker, smoking two cigarettes per day since his late teens.

POA4417 A male in his 40s developed work-related asthma from exposure to dusts from concrete, cutting tile and grout while performing residential remodeling. He was never properly fit-tested for a respirator. He developed a cough, shortness of breath, chest tightness and wheezing, which became worse while at work and worse as the work week progressed. He was prescribed an inhaler and a steroid in the emergency department. Since his diagnosis, he was assigned to jobs without those exposures. He formerly smoked a half a pack of cigarettes per day for five years in his teens.

AA4399 A male in his 20s experienced an exacerbation of his childhood asthma from exposure to construction dust, heat and diesel fumes where he worked at an excavation construction site. He experienced wheezing and shortness of breath. At the emergency department, he was prescribed an Albuterol inhaler, an Albuterol nebulizer and Arnuity. He was a life-long non-smoker.

AA4402 A male in his 50s experienced an exacerbation of his pre-existing asthma from exposure to dust and mold while doing home improvement projects. He experienced wheezing and shortness of breath and was prescribed Flovent and Albuterol in the emergency department. He was a current smoker and smoked half of a pack of cigarettes per day since his 40s.

OA4382 A male in his 40s developed occupational asthma after 16 years of exposure to welding fumes without the use of a respirator, while performing welding activities for various contract welding jobs. He developed wheezing, a cough, chest tightness and shortness of breath, which worsened during his shift and on first days back to work. He quit this job eight years after his asthma was diagnosed. Since then, his asthma has improved although he requires a greater amount of asthma medication. He was a life-long non-smoker.

POA4364 A self-employed carpenter in his 40s developed work-related asthma 12 years after working on residential homes, doing framing, flooring and other renovations. He developed a cough and shortness of breath. He was prescribed an inhaler. He was a life-long non-smoker.

FOOD & ACCOMODATIONS SERVICES

Exposure to miscellaneous substances

OA4368 A male in his 60s developed work-related asthma from exposure to a two-part epoxy bathtub paint and stripper solution at the hotel where he worked as a maintenance man. At first, he would apply the materials to the bathtubs using a paint roller. He used an N95 mask. To speed up the process, the hotel had him spray the materials to larger surface areas than were indicated on the precaution labels. He developed wheezing, a cough, chest tightness and shortness of breath. He was hospitalized twice. He was prescribed Prednisone, Symbicort, and a rescue inhaler. After this incident, he quit this job due to his asthma, and his asthma has improved. He formerly smoked half of a pack of cigarettes per day for 40 years but quit in his early 60s.

AA4378 A male in his 20s experienced an exacerbation of his pre-existing asthma at the restaurant where he worked as a cook, from exposure in a hot, smoky restaurant kitchen when the grill was being cleaned. He experienced chest tightness and shortness of breath. He was taken by ambulance to the emergency department where he was prescribed Prednisone, Zyrtec and Flonase. He was still off work at the time of the interview, trying to decide if he should quit this job because of his asthma. Since this incident, his asthma has worsened, and he requires a greater amount of asthma medication. He was a life-long non-smoker.

RADS4394 A male in his 50s developed RADS from an acute exposure to heated degreaser at a fast-food restaurant where he was a cook. The maintenance staff had cleaned a fryer with a degreaser but had failed to clean out the degreaser from the fryer once they were done. When the fryer was heated up, the fumes took his breath away. He experienced wheezing, cough, chest tightness and shortness of breath. He was prescribed an oral steroid and an Albuterol rescue inhaler at the emergency department. He quit this job because of his asthma and had not found new employment at the time of the interview. Since the incident, he requires less asthma medication. He was a current smoker, smoking a half a pack of cigarettes per day since his 20s.

PUBLIC SERIVCES

Exposure to miscellaneous substances

AA4412 A male policeman in his 20s experienced an exacerbation of his childhood asthma when he was exposed to smoke from a burning apartment building at which he was assisting the fire department. He experienced shortness of breath and was prescribed Albuterol, a steroid inhaler and DuoNeb in the emergency department. He was a life-long non-smoker.

AA4416 A male in his 20s experienced an exacerbation of his childhood asthma when he was exposed to poison sumac while cutting down trees for the road commission. He experienced wheezing, chest tightness and shortness of breath. He used his rescue inhaler at the emergency department. Since no longer being exposed to poison sumac, his asthma has improved, and he requires less asthma medication. He was a life-long non-smoker.

AA4452 A male in his 40s experienced an exacerbation of his pre-existing asthma from exposure to the COVID-19 virus when he performed an EMS/firefighter response for a patient with COVID-19 during the pandemic. The exposure triggered wheezing, a cough, chest tightness and shortness of breath. He was prescribed Advair. Since that exposure, his asthma has worsened, and he requires a greater amount of asthma medication.

POA4434 A male in his 20s developed work-related asthma from exposure to poison ivy and poison sumac which was being trimmed along the building where he performed maintenance. He immediately experienced a cough and shortness of breath and was prescribed Albuterol, a steroid and Symbicort in the emergency department. Since the exposure, he requires a greater amount of asthma medication. He is a life-long non-smoker; however, he does vape.

TRANSPORTATION AND WAREHOUSING

OA4363 A female in her 20s developed work-related asthma from exposure to bleach used to disinfect surfaces during the COVID-19 pandemic, at a package delivery warehouse. The bleach to water ratio was incorrectly mixed with too much bleach. She developed a cough, wheezing, chest tightness and shortness of breath, and was treated in the emergency department with Albuterol. Since her asthma developed, her breathing problems have worsened, and she requires a greater amount of asthma medication. She was a life-long non-smoker.

AA4362 A female in her late teens experienced an exacerbation of her pre-existing asthma at a package delivery warehouse where she was exposed to cleaning agents while cleaning the delivery airplanes. She experienced a cough and shortness of breath. In the emergency department she was treated with Albuterol. She was a life-long non-smoker.

RADS4395 A male in his 50s developed RADS from an acute exposure to bleach and a de-limer that were mixed in a bucket for cleaning on a freighter where he worked as a chef. He immediately experienced wheezing, cough, chest tightness and shortness of breath. He was hospitalized after this exposure and prescribed Solumedrol and DuoNeb. He was a current smoker, smoking a pack of cigarettes a day.

AA4361 A female in her 40s experienced an exacerbation of her pre-existing asthma from exertion while working at a package delivery warehouse where she fulfilled orders and sorted packages. The company had time quotas for the workers, and she also had to frequently climb stairs. She experienced wheezing and shortness of breath and was treated twice in the emergency department. She required a greater amount of her asthma medication, which included Albuterol, Symbicort and a nebulizer. She was a life-long non-smoker.

MISCELLANEOUS SERVICES AND INDUSTRIES

Exposure to cleaning products including disinfectants

AA4407 A woman in her 30s experienced an exacerbation of her pre-existing asthma from exposure to a mixture of cleaning agents when she was cleaning homes. She experienced a cough, chest tightness and shortness of breath.

OA4411 A female in her 60s developed work-related asthma from exposure to increased use of disinfectants while cleaning facilities during the COVID-19 pandemic. She developed a cough, chest tightness and shortness of breath. She was prescribed Prednisone and an inhaler in the emergency department. Her symptoms worsened during her shift and throughout the work week. Her asthma improved on weekends or vacation. She quit this job upon her doctor’s advice and has not been well enough to find new employment. She was a life-long non-smoker.

AA4423 A female in her 30s experienced an exacerbation of her pre-existing asthma from exposure to a mixture of bleach and a sanitizer while performing cleaning work. She immediately experienced wheezing and a cough. At the emergency department, she was prescribed Albuterol. She was a life-long non-smoker.

RADS4389 A female in her 30s developed RADS when she was exposed to fumes from toilet bowl cleaner and bleach being mixed in a bucket in the shower area of a campground where she was an office assistant and guard attendant. She immediately developed a cough, chest tightness and shortness of breath. She was treated in the emergency department and prescribed an inhaler. Since the incident, the campground owners had a meeting to allow bleach to be used only upon special request. Her asthma has improved although she still requires the inhaler. She smoked a pack of cigarettes a day from her early teens but quit smoking after the exposure.

Exposure to miscellaneous substances

AA4404 A female in her 40s experienced an exacerbation of her pre-existing asthma when she was exposed to burning hydraulic fluid from a building located adjacent to her workplace.

AA4375 A female in her 20s experienced an exacerbation of her pre-existing asthma at a car detailing shop. She developed a cough and shortness of breath. She was prescribed Albuterol and Qvar in the emergency department. She was a life-long non-smoker.