

DECEMBER 8, 2021

2020 ANNUAL REPORT

TRACKING WORK-RELATED ASTHMA IN MICHIGAN



2020 ANNUAL REPORT

Work-Related Asthma Surveillance Program

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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



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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.

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 30th 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 asthma¹. 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 1988-2020, 3,820 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 (13.0%) and isocyanates (11.8%), are the most commonly reported exposures causing WRA in MI.
- ◆ Approximately 29,894 individuals in the MI workforce are employed in manufacturing where isocyanates are used.
- ◆ The average incidence rate of WRA among African Americans is 2.1 times greater than that of Caucasians.

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.

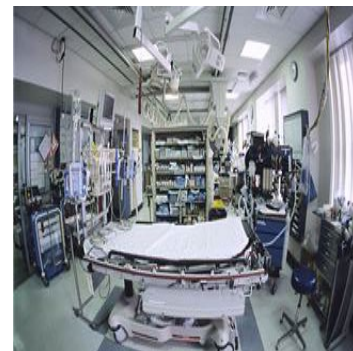
The reporting of an index patient is a sentinel health event that may lead to the identification of employees from the same facilities who are also at risk of developing asthma or who have developed similar breathing problems. The goal is to prevent WRA through the identification and workplace follow-up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



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

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 program is 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.

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

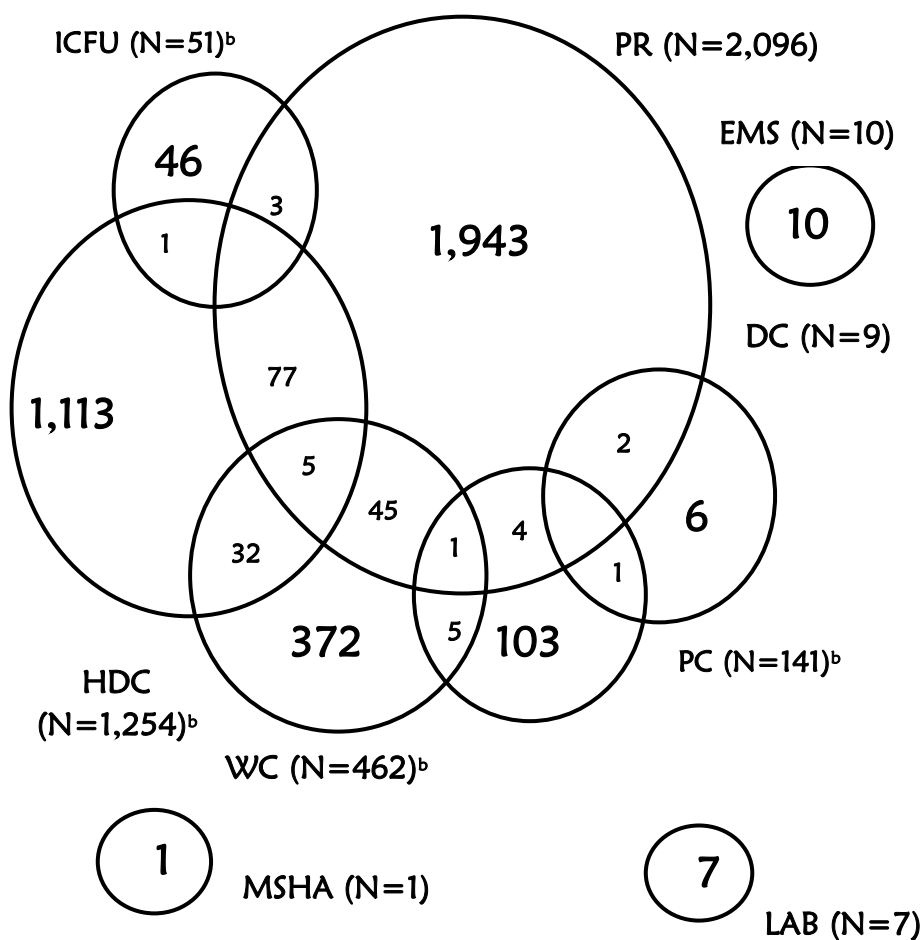
REPORTS

Table 1 shows that 3,820 people were confirmed with WRA between 1988—2020. 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 (6 for 2019 and 46 for 2020). Figure 1 shows the overlap of the patients by reporting sources for 1988—2020.

TABLE 1
Number of Confirmed Cases of WRA by
Year and Type
Disease Status

<u>YEAR</u>	<u>OA</u>	<u>POA</u>	<u>AA</u>	<u>RADS</u>	<u>TOTAL</u>
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
Total	1,230	1,339	829	422	3,820

FIGURE 1
Overlap of Reporting Sources for 3,820 Confirmed
WRA Patients: 1988-2020^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=Poisson 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.

^aReports are still being processed for calendar years 2019 and 2020; an increase in these totals will be reflected in next year's annual report

Demographics – Trends

The analyses conducted for the annual report were divided into 1988-1997, 1998-2007 and 2008-2020 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 1,085 reported from 2008 to 2020. 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 2008-2020 time periods.

GENDER: Table 2 shows a slightly 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 an increase over time in the percentage of Hispanic 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 2.70 per 100,000 Michigan African American workers compared to 1.27 per 100,000 for Michigan Caucasian workers; this was a 2.1 times greater incidence (95% CI 1.218,3.676).

TABLE 2
Gender of WRA Patients by Time Period

	Time Period				
	All years	1988-1997	1998-2007	2008-2020	Change in Percentage
Gender	# (%)	# (%)	# (%)	# (%)	
Female	2,062 (54)	626 (49)	800 (55)	636 (59)	+ 20%
Male	1,758 (46)	648 (51)	661 (45)	449 (41)	- 20%

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 3
Race of WRA Patients by Time Period

	Time Period				
	All years	1988-1997	1998-2007	2008-2020	Change in Percentage
Race	# (%)	# (%)	# (%)	# (%)	
Caucasian	2,749 (72)	973 (76)	1,074 (74)	702 (65)	-14%
African American	721 (19)	239 (19)	271 (19)	211 (19)	None
Hispanic	87 (2)	24 (2)	27 (2)	36 (3)	+ 50%
Alaskan/Am Indian	34 (1)	10 (1)	13 (1)	11 (1)	None
Asian	15 (<1)	4 (0.3)	7 (0.5)	4 (0.4)	+ 33%
Other	42 (1)	11 (1)	20 (1)	11 (1.1)	None
Unknown	172 (5)	13 (1)	49 (3)	110 (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 (10.0 cases per 100,000), Clare (7.4 cases per 100,000), Montmorency (5.2 cases per 100,000), Osceola (4.9 cases per 100,000), Genesee (4.6 cases per 100,000), Huron (4.5 cases per 100,000) and Saginaw (4.4 cases per 100,000).

TABLE 4
Average Annual Incidence Rates of WRA Among Michigan Workers by County of Exposure: 1989-2018^a

Avg Annual Cases			Avg Annual Cases		
County	# EE's ^b	Inc Rate ^c	County	# EE's ^b	Inc Rate ^c
Alcona	3,734	0.9	1 Keweenaw	944	3.5
Alger	4,048	2.5	3 Lake	3,998	1.7
Allegan	49,958	3.7	56 Lapeer	41,905	2.9
Alpena	13,970	2.6	11 Leelanau	10,874	1.8
Antrim	11,088	0.9	3 Lenawee	45,730	2.4
Arenac	7,103	2.6	5 Livingston	89,055	1.5
Baraga	3,556	3.7	4 Luce	2,654	10.0
Barry	28,596	1.0	9 Mackinac	5,885	2.3
Bay	51,802	1.7	27 Macomb	396,780	2.6
Benzie	8,227	1.6	4 Manistee	10,779	1.2
Berrien	72,422	1.4	31 Marquette	32,565	2.3
Branch	21,277	4.1	26 Mason	13,773	1.7
Calhoun	66,888	2.4	48 Mecosta	18,531	1.6
Cass	25,616	0.7	5 Menominee	12,597	0.3
Charlevoix	13,105	2.5	10 Midland	38,738	2.8
Cheboygan	11,681	3.7	13 Missaukee	6,201	2.2
Chippewa	15,906	1.3	6 Monroe	72,474	1.4
Clare	12,133	7.4	27 Montcalm	27,319	2.4
Clinton	34,977	0.9	9 Montmorency	3,817	5.2
Crawford	6,234	3.2	6 Muskegon	82,728	1.1
Delta	18,700	2.1	12 Newaygo	21,238	2.8
Dickinson	13,496	3.7	15 Oakland	606,421	2.5
Eaton	55,176	0.8	13 Oceana	12,741	1.3
Emmet	18,249	1.1	6 Ogemaw	8,987	3.7
Genesee	194,369	4.6	269 Ontonagon	3,300	1.0
Gladwin	9,983	1.0	3 Osceola	9,575	4.9
Gogebic	7,217	1.4	3 Otsego	11,720	3.1
Gd Traverse	44,511	1.6	21 Ottawa	126,705	0.8
Gratiot	18,680	2.1	12 Roscommon	10,306	2.6
Hillsdale	20,675	2.1	13 Saginaw	90,548	4.4
Houghton	16,137	1.4	7 Sanilac	19,894	3.5
Huron	15,636	4.5	21 Schoolcraft	3,588	1.9
Ingham	143,327	3.3	141 Shiawassee	33,900	0.6
Ionia	28,133	1.5	13 St. Clair	78,920	2.6
Iosco	9,617	1.7	5 St. Joseph	28,932	1.5
Iron	5,480	2.4	4 Tuscola	26,833	3.0
Isabella	35,007	2.8	29 Van Buren	37,417	1.0
Jackson	72,274	2.4	53 Washtenaw	179,602	3.6
Kalamazoo	123,752	1.5	55 Wayne	837,179	3.4
Kalkaska	8,036	3.7	9 Wexford	13,468	1.7
Kent	297,020	1.2	106 All Counties^d	4,706,000^e	2.5
					3,568

^a 1989 through 2018 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2019 and 2020 is not yet complete. Therefore, 1988, 2019 and 2020 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 1989-2018 (30 years), per 100,000 Michigan workers.

^d Fifty-nine cases had an out-of-state exposure and 22 had an unknown county of exposure, for the 1989-2018 reporting period.

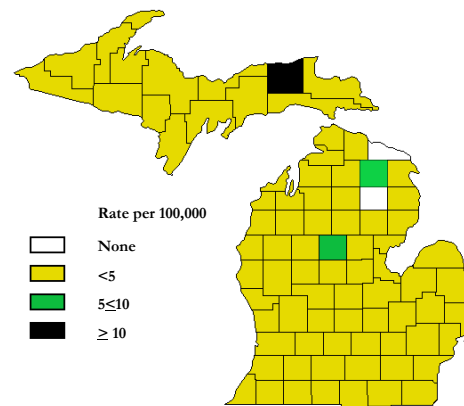
^e Total is rounded up.

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 1989-2018 time period. All of the top counties with the highest overall rates of WRA had a decrease of 10% or greater, except for Huron county, in the rate of WRA over time. Many of the rates increased during the 1998-2007 time period but then decreased during the 2008-2020 time period.

FIGURE 2
Average Annual Incidence Rate of WRA by County of Exposure: 1989-2018^a



^a 1989 through 2018 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2019 and 2020 is not yet complete. Therefore, 1988, 2019 and 2020 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			2008-2020			
County	Rate	# Cases	# EE's ^a	Rate	# Cases	# EE's ^b	Rate	# Cases	# EE's ^c	Rate	Change in Percentage
Branch	4.1	7	17,699	4.0	12	21,340	5.6	7	17,507	3.1	- 23%
Cheboygan	3.7	8	9,658	8.3	2	11,422	1.8	3	9,277	2.5	- 70%
Clare	7.4	8	9,100	8.8	11	11,761	9.4	10	10,592	7.3	-17%
Genesee	4.6	83	179,394	4.6	132	191,377	6.9	62	161,918	2.9	- 37%
Huron	4.5	7	14,941	4.7	8	15,499	5.2	11	14,567	5.8	+23%
Kalkaska	3.7	4	6,188	6.5	4	7,932	5.0	1	6,680	1.2	- 82%
Luce	10.0	4	2,021	19.8	2	2,660	7.5	2	2,163	7.1	- 64%
Montmorency	5.2	0	2,868	--	2	3,781	5.3	4	2,836	10.8	+104
Osceola	4.9	2	9,343	2.1	10	9,938	10.1	2	8,970	1.7	- 19%
Saginaw	4.4	31	91,307	3.4	67	90,388	7.4	28	79,625	2.7	- 24%
Sanilac	3.5	5	17,992	2.8	12	19,452	6.2	4	16,923	1.8	- 36%
All MI Counties	2.5	1,274	4,258,000	3.0	1,461	4,702,000	3.1	1,085	4,194,000	2.0	-33%

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

^bSource: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 2002.

^cSource: MI Dept of Tech, Mgt, & Budget, Labor Market Information, Annual Unemployment Statistics (LAUS) by County, 2010.

Type of Industry – Trends

Table 6 shows the Michigan industries by NAICS codes, with cases of work-related asthma from 1988 to 2020. 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 9.8 cases per 100,000 in manufacturing. Industries with the next highest average annual incidence rates were: mining with 6.8 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 36.7% in 2008-2020. 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, 1988-2020 by Primary Industrial Exposure and
Average Annual Incidence Rate per 100,000 Workers, 1989-2018 (Years of Complete Reporting)

2002 N American Industry Classification System		WRA Cases 1988-2020		Number of Employees ^a	Average Ann. Incidence Rate ^b	
		#	%		Rate	# Cases
11	Agriculture, Forestry, Fishing, & Hunting	30	0.8	79,883	1.2	28
21	Mining	13	0.3	6,400	6.8	13
22	Utilities	23	0.6	35,300	2.1	22
23	Construction	104	2.7	189,690	1.8	101
31-33	Manufacturing	2,117	55.4	695,885	9.8	2,042
42	Wholesale Trade	42	1.1	169,735	0.7	38
44-45	Retail Trade	127	3.3	512,474	0.8	119
48-49	Transportation & Warehousing	79	2.1	100,137	2.5	74
51	Information	24	0.6	67,973	1.2	24
52	Finance & Insurance	36	0.9	156,375	0.7	35
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	33
55	Mgt of Companies & Enterprises	2	0.1	67,988	0.1	2
56	Administrative & Support & Waste Mgt	93	2.4	271,673	1.0	80
61	Educational Services	171	4.5	437,200	1.2	163
62	Health Care & Social Assistance	476	12.5	480,330	3.2	458
71	Arts, Entertainment & Recreation	34	0.9	61,137	1.7	32
72	Accommodation & Food Services	124	3.2	339,052	1.1	116
81	Other Services (except Public Admin)	95	2.5	178,600	1.6	84
92	Public Administration	151	4.0	252,700	1.9	144
00	Unknown	25	0.7	--	--	22
Total		3,820		4,456,600	2.7	3,649

^aSource: 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.

^bReporting in 1988 was begun mid-year and reporting for 2019 and 2020 is not yet complete. Therefore, 1988, 2019 and 2020 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 1989-2018 (30 years), per 100,000 Michigan workers.

TABLE 7
2,042 WRA Patients from Manufacturing Industries:
1989-2018^a

2002 North American Industry Classification System		# WRA Cases	Avg Ann Rate ^a	# Employees ^b
311	Food Mfg	70	7.1	32,729
323	Printing & Related Support Activities	19	3.5	18,327
325	Chemical Mfg	109	13.1	27,704
326	Plastics & Rubber Products Mfg	115	8.9	43,056
327	Nonmetallic Mineral Product Mfg	19	3.8	16,512
331	Primary Metal Mfg	70	8.4	27,648
332	Fabricated Metal Product Mfg	123	4.9	83,121
333	Machinery Mfg	158	6.9	75,925
334	Computer & Electronic Product Mfg	15	2.6	19,165
336	Transportation Equipment Mfg	1,176	15.3	255,913
337	Furniture & Related Product Mfg	16	2.0	26,167
	Miscellaneous Mfg (*includes NAICS: 312-16,321-322,324,335,339)	152	7.3	69,619

^aAverage annual incidence rate, based on cases from 1989-2018 (30 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 2019 and 2020 is not yet complete. Therefore, 1988, 2019 and 2020 reports are not included in this table.

^bSource: 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		2008-2020		
NAICS	Industry	#	%	#	%	#	%	Change in Percentage
11	Agriculture, Forestry, Fishing, & Hunting	4	0.3	12	0.8	14	1.3	+ 333%
21	Mining	5	0.4	6	0.4	2	0.2	- 50%
22	Utilities	3	0.2	5	0.3	15	1.4	+ 600%
23	Construction	32	2.5	37	2.5	35	3.2	+28%
31-33	Manufacturing	912	71.6	809	55.4	398	36.7	- 49%
42	Wholesale Trade	23	1.8	14	1.0	6	0.6	- 67%
44-45	Retail Trade	15	1.2	48	3.3	62	5.7	+ 375%
48-49	Transportation & Warehousing	14	1.1	35	2.4	30	2.8	+ 155%
51	Information	6	0.5	11	0.8	7	0.6	+ 20%
52	Finance & Insurance	2	0.2	17	1.2	17	1.6	+ 700%
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	56	5.2	+ 550%
61	Educational Services	40	3.1	73	5.0	58	5.3	+ 71%
62	Health Care & Social Assistance	105	8.2	194	13.3	177	16.3	+ 99%
71	Arts, Entertainment & Recreation	5	0.4	11	0.8	18	1.7	+ 325%
72	Accommodation & Food Services	19	1.5	49	3.4	55	5.1	+ 240%
81	Other Services (except Public Administration)	22	1.7	31	2.1	42	3.9	+129%
92	Public Administration	44	3.5	46	3.1	61	5.6	+ 60%
00	Unknown	2	0.2	8	0.5	15	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 importance of the automotive manufacturing industry in the State, and the widespread use of cleaning products across all industry sectors. Most frequently identified exposures include: cleaning products, associated with 498 (13.0%) of Michigan's WRA patients, and isocyanates (MDI, TDI, HDI and others) accounting for 451 (11.8%) of the WRA case exposures. Metal working fluids (coolants) accounted for 335 (8.8%) 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, such as services and manufacturing, 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 2011 publication highlights the morbidity and high health care costs from asthma associated with welding³.

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 7.3% in 2008-2020. Cleaning agents increased from 4.6% of all the WRA exposures in 1988-1997 to 20.7% in 2008-2020. 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 1988-2019. 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. Diisocyanates were decreasing until 2010-2011. 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: 1988-2020

Exposure Agent	#	%
Cleaning Solutions	498	13.0
Isocyanates	451	11.8
Metal Working Fluids	335	8.8
Unknown (Mfg.)	276	7.2
Unknown (Office)	211	5.5
Exhaust/Smoke/Fumes	177	4.6
Welding Fume-Stainless & Other	163	4.3
Solvents	115	3.0
Paint Fumes	94	2.5
Fungus	90	2.4
Epoxy	86	2.3
Acids	72	1.9
Formaldehyde	68	1.8
Fire	68	1.8
Latex/Rubber	63	1.6
Chlorine	55	1.4
Construction Exposures	55	1.4
Plastic Fumes	52	1.4
Animal Dander	47	1.2
Acrylates	39	1.0
Fragrances	36	0.9
Cobalt	33	0.9
Wood Dust	32	0.8
Flour	29	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
Chromium	16	0.4
Amines	16	0.4
Medication	16	0.4
Cement Dust	15	0.4
Cosmetology Chemicals	14	0.4
Plants/Organic Matter	14	0.4
Asphalt	14	0.4
Caustics	14	0.4
Fire Extinguisher Powder	14	0.4
Rust Inhibitor	13	0.3
Printing Inks	13	0.3
Grain Dust	13	0.3
Metal Dust	12	0.3
Anhydrides	11	0.3
Heat	10	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	294	7.7
Total	3,820	

^aThere were 7 cases each with exposure to: Azodicarbonamide, Cold Air, Cooking Oil, Enzymes, Pepper Gas, Polyurethane.

There were 6 cases each with exposure to: 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, Exercise, Mold Release Spray, Photo Developing Fluids.

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

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

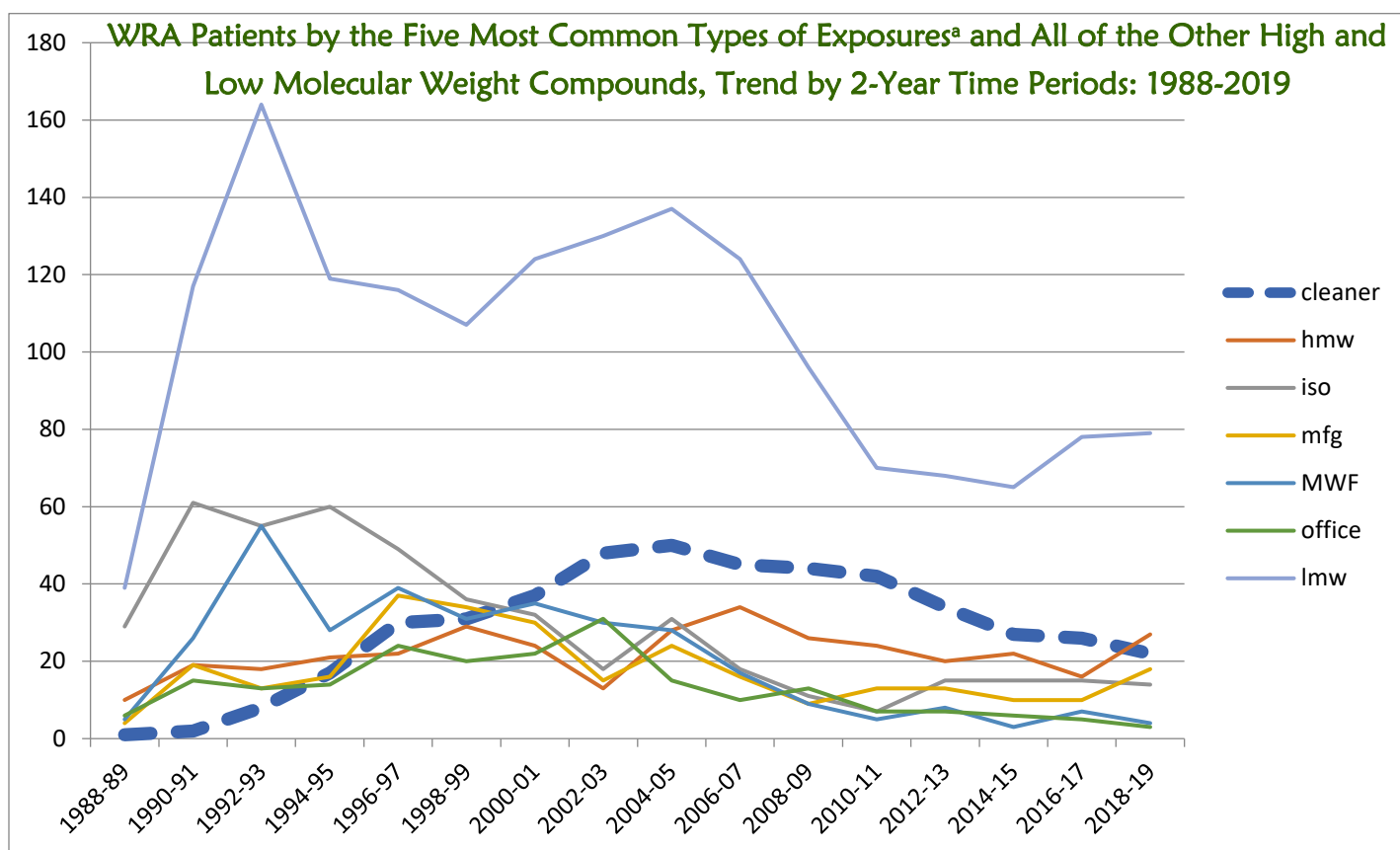
There were 2 cases each with exposure to: Ammonium Chloride, Barbeque Smoker, Bitrex, Calcium Chloride (used in Cherry Brine), Car Window Sealant, Carbon Dioxide, Cellulose, Concrete Sealer, Copper Oxide, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Glaze, Heated Polyvinyl Chloride, Isopropyl 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, Iodine, Laboratory 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, 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	2008-2020	Change in Percentage
Exposure Type	# (%)	# (%)	# (%)	# (%)	
Cleaning Agents	498 (13.0)	59 (4.6)	214 (14.6)	225 (20.7)	+ 350%
Isocyanates	451 (11.8)	246 (19.3)	126 (8.6)	79 (7.3)	- 62%
Metalworking Fluids	335 (8.8)	153 (12.0)	144 (9.9)	38 (3.5)	- 71%
Welding Fume	163 (4.3)	63 (4.9)	62 (4.2)	38 (3.5)	- 29%
Solvents	115 (3.0)	51 (4.0)	52 (3.6)	12 (1.1)	- 73%
Paint	94 (2.5)	18 (1.4)	49 (3.4)	27 (2.5)	+ 79%
Epoxy	86 (2.3)	33 (2.6)	28 (1.9)	25 (2.3)	- 12%
Fungus	90 (2.4)	0	41 (2.8)	49 (4.5)	+ 61%
Formaldehyde	68 (1.8)	33 (2.6)	19 (1.3)	16 (1.5)	- 42%
Acids	72 (1.9)	27 (2.1)	24 (1.6)	21 (1.9)	- 10%
Latex/Rubber	63 (1.6)	25 (2.0)	33 (2.3)	5 (0.5)	- 75%

FIGURE 3



^aCleaner=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 2019 (18.7%) (most recent year available, source, CDC BRFSS results, www.cdc.gov). **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). Sixteen 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-six percent of the WRA patients had at least one visit to the Emergency Department (ED) in their lifetime for their WRA, and 35% 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 3.7.

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 (Case ID 4167). There were no work-related asthma deaths identified in calendar years 2009 through 2014 and in 2016 or 2017. There was one work-related asthma death each in 2015 and 2018. In addition, we have published articles on some of the work-related asthma deaths^{4,5}.

TABLE 11
Cigarette Smoking Status of 3,671^a
Confirmed WRA Patients: 1988-2020

	Smoking Status						
	Current		Ex-Smoker		Non-Smoker		TOTAL
	#	%	#	%	#	%	
OA	247	20.5	460	38.2	497	41.3	1,204
POA	200	15.3	524	40.2	581	44.5	1,305
AA	162	21.4	195	25.8	400	52.8	757
RADS	109	26.9	151	37.3	145	35.8	405
All	718	19.6	1,330	36.2	1,623	44.2	3,671

^aMissing data on 149 patients.

TABLE 12
Cigarette Smoking Status of WRA Patients by Time Period

	Time Period				
	All Years	1988-1997	1998-2007	2008-2020	Change in Percentage
Smoking Status	# (%)	# (%)	# (%)	# (%)	
Current	718 (20)	243 (20)	295 (21)	180 (18)	- 10%
Ex-Smoker	1,330 (36)	540 (43)	479 (34)	311 (31)	- 28%
Non-Smoker	1,623 (44)	463 (37)	632 (45)	528 (52)	+ 41%
Total	3,671 ^a	1,246	1,406	1,019	

^aMissing data on 149 patients.

TABLE 13

Personal History of Allergies or Asthma Among 3,465^a Confirmed WRA Patients: 1988-2020

Personal History of...

	Allergies & Asthma		Asthma Only		Allergies Only		No Allergies or Asthma	
	#	%	#	%	#	%	#	%
OA	66	5.8	58	5.1	341	30.1	669	59.0
POA	93	7.7	61	5.0	420	34.8	634	52.5
AA	393	50.7	343	44.3	19	2.5	20	2.6
RADS	17	4.9	36	10.3	86	24.7	209	60.1
All	569	16.4	498	14.4	866	25.0	1,532	44.2

^aMissing data on 355 patients.

TABLE 14

Health Care Usage Among Confirmed WRA Patients: 1988-2020

Lifetime History of Health Care Usage

ED Visit ^a		Hospitalized ^b	
Yes # (%)	No # (%)	Yes # (%)	No # (%)
2,374 (66)	1,212 (34)	1,174 (35)	2,207 (65)
Range 1-300 visits		Range 1-200 hospitalizations	
AVG 5.4 ±14.6		AVG 3.7±9.7	

^aMissing data on 234 patients.^bMissing data on 439 patients.

SYMPTOMS

Two thousand nine hundred forty-eight (2,948) 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: Approximately 70% of the cases were no longer exposed to the agent associated with their WRA and this did not change over time. 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 2008-2020, 24% of those still exposed reported an improvement in symptoms, compared to 44% 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 2008-2020, compared to 31% among those no longer exposed.

TABLE 15

Persistence of Symptoms and Medication Use in 3,400 Confirmed WRA Patients: 1988-2020

Still Exposed?	Total	Breathing Problems Still Present?				Still Taking Asthma Medications?			
		Yes		Less		Yes		Less	
		#	%	#	%	#	%	#	%
Yes	979	931	95.1	286	29.2	852	87.0	171	17.5
No	2,421	2,017	83.3	1,135	46.9	1,892	78.1	696	28.7
Total	3,400 ^a	2,948		1,421		2,744		867	

^aInformation missing on 420 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 %	#	Less %	#	Yes %	#	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	
2008-2020	Yes	251	229	91.2	61	24.3	228	90.8	35	13.9
	No	646	484	74.9	281	43.5	499	77.2	199	30.8
	Total	897	713		342		727		234	
Change in Percentage	Yes			-5%		-29%		+7%		-34%
	No			-9%		-12%		+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	2008-2020	Change in Percentage
Test Type	(%)	(%)	(%)	(%)	
Pre-post Bronchodilatation	49	54	54	37	- 31%
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

^aNot 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 44% 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 2008-2020. 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 819 workplace inspections have been conducted since 1988 (Table 18); 123 of those facilities had been inspected more than once. There were no inspections since last year's report 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: 1988-2020

Inspection Status	# Patients	Companies	
	Represented	#	%
Inspected	1,279	819 ^a	29.8
No Follow-up Planned	2,319	1,727	62.8
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	3,820	2,752 ^c	

^a819 inspections were conducted in 696 different workplaces.

^bEight companies that no longer use the suspected causal agent were previously inspected.

^cRepresents 2,629 different facilities.

^dThe 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: 1988-2020

Air Sampling – NIOSH Standard	#	%
Above NIOSH Standard	69	8.4
Below NIOSH Standard	485	59.2
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	197	24.1
Total	819	
Air Sampling – MIOSHA Standard	#	%
Above MIOSHA Standard	31	3.8
Below MIOSHA Standard	547	66.8
No MIOSHA Standard	7	0.9
Unknown (no report yet)	4	0.5
Did Not Sample for an Allergen	33	4.0
Did Not Sample	197	24.1
Total	819	

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

TABLE 20
Suspected Causal Agents Above the MIOSHA Permissible Exposure Limit (PEL)
and/or NIOSH Recommended Exposure Limit (REL): Michigan 1988-2020

	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

^aPercentages do not add to 100 due to rounding.

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

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:
1988-2020 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
2008-2019	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
2008-2020	116	9	7.8
Total Workers with Symptoms ^a		2,221	

^aTen 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.

Between the two reporting sources, there were 95 companies that reported using isocyanates in 2020, which is slightly less than the 104 companies in 2019, the 106 companies from 2018 and the 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. The 29,894 workers in 2020 are almost half of the 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 2020
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 YAN FENG AUTOMOTIVE INTERIORS PMSC	562	57,710	1.0
BARRY	BRADFORD WHITE CORP	900	29,033	3.1
BAY	QUANTUM COMPOSITES INC	14	45,009	<0.1
BERRIEN	LECO CORP	9	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
CRAWFORD	WEYERHAEUSER	200	5,070	3.9
DICKINSON	GREDE, LLC IRON MOUNTAIN LOUISIANA-PACIFIC-SAGOLA OSB	725	11,347	6.4

Table 22. County	Company Name^{a,d}	# Workers Employed by Isocyanate-Using Facilities	Total # Workers in the County^e	% Workers Potentially Exposed to Isocyanates
EATON	ALLIANCE INTERIORSSIKAAXON US	60	51,803	0.1
GENESEE	ASI PACKAGING COMPANY CREATIVE FOAM (FENWAY BUSINESS UNIT) LANDAAL PACKAGING SYSTEMS	454	159,859	0.3
HILLSDALE	ESSEX SPECIALTY PRODUCTS	5	18,261	<0.1
HURON	VALLEY ENTERPRISES	11	14,231	0.1
INGHAM	HUNTSMAN ADVANCED MATERIALS SA AUTOMOTIVE WILLIAMSTON PRODUCTS INC	460	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 GRAND RAPIDS FOAM TECHNOLOGIES HB FULLER KENDRICK PLASTICS LACKS WHEEL TRIM SYSTEMS, BARDEN PLATER	730	330,032	0.2
LENAWEE	ANDERSON DEVELOPMENT INSULSPAN INTEVA PRODUCTS	621	41,492	1.5
LIVINGSTON	ANTOLIN-HOWELL PACKAGE DESIGN MFG INC	752	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 L & L PRODUCTS MAYCO INTERNATIONAL MOON ROOF CORP OF MI ROMEO RIM INC SHELBY FOAM SYSTEM WOLVERINE BRONZE	3,231	386,942	0.8
MARQUETTE	ARGONICS—MI PLANT	37	29,121	0.1
MASON	GREAT LAKES CASTING	160	12,142	1.3
MIDLAND	CENTRAL WAREHOUSE –MIDLAND DDP SPECIALTY ELECTRONIC PARTS LLC	897	36,742	2.4
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 FANUC ROBOTICS—CORP HDQTRS LYMTAL INTERNATIONAL INC RECTICEL UREPP N AMERICA SERVICE PARTNERS WEBASTO ROOF SYSTEMS	2,467	588,572	0.4

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	LIVEWELL WAREHOUSE MAGNA ENGINEERED GLASS ROYAL TECH	2,022	148,077	1.4
SAGINAW	GLASTENDER NEXTEER AUTOMOTIVE CORP POREX TECHNOLOGIES	1,036	76,397	1.4
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
WASHTENAW	FAURECIA INTERIOR SYSTEMS	1,785	181,294	1.0
WAYNE	ALPHA RESINS BASF CORP—LIVONIA PLANT BASF CORP—WYANDOTTE PLANT BAY LOGISTICS CYGNET AUTOMATED CLEANING EFTEC TAYLOR EQ DETROIT NORTHFIELD MFG PLASTOMER CORP PROGRESSIVE DISTRIBUTIONS CENTERS WEBASTO ROOF & COMPONENTS WINDSOR MACHINE & STAMPING (US) LTD WOODBIDGE CORP	1,753	686,888	0.3
WEXFORD	REC BOAT HOLDINGS-CRUISER PLANT REC BOAT HOLDINGS-SPORT/ENGINEERING TJS WAREHOUSE	480	13,402	3.6
TOTAL		29,894	3,830,266	0.8

^aSource: Manta.com, accessed 11/24/2021.

^bSource: Michigan Labor Market Information, Data Explorer, www.milmi.org accessed 11/24/2021.

^cSource: U.S. Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2020, data accessed 11/22/2021.

^dSource: MI Dept of Environment, Great Lakes, and Energy (EGLE), FOIA Request for SARA Title III Emergency Planning & Release Reporting of isocyanates, for calendar year 2020, received 11/29/2021.

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 MI EGLE SARA Title III Emergency Planning and Release Reporting for calendar year 2020.

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 Toxic Chemicals to the MI Dept. of Environment, Great Lakes, and Energy (EGLE) in 2020, Under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA)^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	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
ALLEGAN	ADVANCED ARCHITECTURAL PRODUCTS	S	BERRIEN	LETIZ FARMS	A
	CONAGRA FOODS LLC	A,CH		NCP COATINGS	A,P
	DOUGLAS MARINE CORP	S		NEW BUFFALO WATER PLT	CH
	HUDSONVILLE CREAMERY & ICE CREAM	A		NILES, CITY - DECKER, FRONT WELLS & IRON REMOVAL	CH
	JBS PLAINWELL, INC.	A	BRANCH	OLD EUROPE CHEESE INC	A
	OTSEGO, CITY WELLS #3, #4, #6	CH		CLEMENS FOOD GROUP	A
	SHERWIN WILLIAMS CO- HOLLAND	A		QUINCY	CH
	TIARA YACHTS INC	S		REAL ALLOY RECYCLING INC	CH
	THE AMERICAN BOTTLING COMPANY	A	CALHOUN	WATER PLT/COLDWATER	CH
	WATER RENEWAL	CH		ALBION PLANT	A
ANTRIM	BFI ELK RAPIDS	A		ANATECH, LTD.	F
	JORDAN RIVER NAT FISH HATCHERY	F		ARMSTRONG FACILITY	S
ARENAC	WHITESTONE PUMPING STATION	CH		BATTLE CREEK WWTP	CH
BARRY	CALEDONIA FARMERS ELEVATOR	A		BLEISTAHL	CO
	WATER TREATMENT FACILITY	CH		HOMER	A
BAY	BAY CARBON INC	CH		MARSHALL CITY WATER	CH
	MERSEN USA GS CORP	CH		MUSASHI AUTO PARTS-MI INC	A
	QUANTUM COMPOSITES, INC.	S		POST FOODS - BATTLE CREEK	CH
	WEST BAY CTY REGIONAL WW	CH		RBT J SWALWELL WWTP	CH
BENZIE	GRACELAND FRUIT, INC.	A	CASS	THE MENNEL MILLING CO. OF MI	CH
	PLATTE RIVER ST FISH HATCHERY	F		UNION HIGH SCHOOL	F
	SMELTZER ORCHARD COMPANY	A	CHEBOYGAN	CHEBOYGAN WELLHOUSE #4,#7 & WWTP	CH
BERRIEN	ADVANCE PRODUCTS CORP	A	CHIPPEWA	PENDILLS CREEK NFH	F
	BLUEWATER THERMAL SOLUTIONS	A		PULLAR COMMUNITY BUILDING	A
	BUCHANAN AGRON. & PETRO.	A		SAULT STE MARIE WWTP & WATER	CH
	BUCHANAN WATER & WWTP	CH		SULLIVAN CREEK NFH	F
	CHAMPLAIN SPECIALTY METALS	A	CLINTON	MAHLE ENGINE COMPONENTS USA	A
	COLOMA FROZEN FOODS INC	A		MARTIN BROWER	A
	FREEZER/REPACK CTR	A		MICHIGAN MILK PRODUCERS ASSOC	A
	GREG ORCHARD	A		MWC LLC	A
	HANSON COLD STORAGE	A		NUTRIEN AG SOLUTIONS 879	A

Table 23, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
CLINTON	SAVE-A-LOT LTD	A	INGHAM	ARCTIC GLACIER—LANSING	A
	SCCMUA	CH		AURORA SPECIALTY CHEMISTRIES	E
	ST JOHNS WWTP	CH		CREMER FARM CENTER, INC.	A
CRAWFORD	ARCTIC GLACIER INC	A		DYE WATER CONDITIONING PLANT	A
DELTA	ESCANABA WATER & WWTP	CH		MER TWP WATER & SEWER	A
	VERSO ESCANABA LLC	A,CH		JORGENSEN FARM ELEVATOR	A
EATON	ETM ENTERPRISES INC.	S		MASON P.O.T.W. PLANT	
	LANSING PLANT	A,CH		MICHIGAN STATE UNIVERSITY	
	MEIJER LANSING DISTRIBUTION	A		NITREX INC - MICHIGAN OPERATION	
	SIKA ADVANCED RESINS US	S		PREMIER THERMAL SOLUTIONS LLC	
EMMET	INTERTOWN	CH		TECOMET-LANSING	
	LIMEKILN	CH		WILLIAMSTON WATER TREAT PLT	
	NORTHMAN WELL HOUSE	CH		WISE WATER CONDITIONING PLANT	
	ODEN STATE FISH HATCHERY	F	IONIA	BELDING TANK TECHNOLOGIES, INC	S
	PRESERVE WELLHOUSE	CH		CARGILL KITCHEN SOLUTIONS	A
GD TRAVERSE	CENTRE ICE	A		FARM DEPOT 3 LTD	S
	CENTURY SUN METAL TREATING	A		GALLAGHERS	A
	SARA LEE FROZEN BAKERY LLC	A		HENNERY	A
	TCS TRAVERSE COLD STORAGE LLC	A		MAIN FARM	A
	TRAVERSE CITY	CH		ROBROY ENCLOSURES	S
GENESEE	A RAGNONE TREATMENT PLANT	CH		THK RHYTHM AUTOMOTIVE	A
	CENTER ROAD, N PUMP STATION	CH		TWIN CITY FOODS	A, CH
	HENDERSON ROAD PUMP STATION	CH	IOSCO	HURON SHORE REGIONAL UTILITY A	CH
	KOEGEL MEATS INC.	A		TAWAS UTILITY AUTHORITY WWTP	CH
	STOKES STEEL TREATING CO	A		TIP TOP SCREW MFG INC	A
	WATER POLLUTION CONTROL FAC	CH	JACKSON	CHEMETALL US INC	A,MA
	WOODWORTH INC. FLINT	A		CITY OF JACKSON WATER	CH
GOGEBIC	IRONWOOD PLASTICS INC	F		COVENTRY PARK	CH
GRATIOT	ALMA WASTEWATER PLANT	CH		INDUSTRIAL STEEL TRAINING	A
	CITY OF ST. LOUIS WWTP	CH		JCC WELL HOUSE	CH
HILLSDALE	BEF FOODS INC.	A		KIMMEL ROAD WELL HOUSE	CH
	CONAGRA FOODS INC	A		MEADOW HEIGHTS WELL	CH
	HILLSDALE WWTP	CH		SOUTHVIEW PUMP STATION	CH
	PRATTVILLE FERTILIZER & GRAIN	A		WESTCHESTER PUMP STATION	CH
	THE ANDERSONS LITCHFLD FARM	A		WSU	A,CH
HOUGHTON	WARM RAIN CORP	S	KALAMAZOO	BELL'S BREWERY INC	A
HURON	BAD AXE WWTP	CH		CITY OF KALAMAZOO- #28,#39	CH
	CORTEVA AGROSCIENCES LLC	A		KALAMAZOO	A,CH
	FARMERS CO-OP GRAIN CO.	A		KALAMAZOO WATER #1-#5, #8-9	CH
	HARBOR BEACH WATER & WWTP	CH		#11-12, #14, #22, #24-25, #31	
	THUMB TOOL & ENGINEERING	A		KNAPPEN MILLING CO	CH
INGHAM	ALDI INC - WEBBERVILLE	A		PHARMACIA & UPJOHN LLC	A,CH,E,F

Table 23, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
KALAMAZOO	PRECISION HEAT TREATING COMPANY	A	KENT	UNIVAR USA	B
	RICHARD-ALLAN SCIENTIFIC	F		VILLAGE OF SPARTA WATER	CH
	WESTERN MICHIGAN UNIVERSITY	A		WALKER ICE AND FITNESS	A
KENT	29th STREET WAREHOUSE	S	KEWEENAW	WYOMING CLEAN WATER PLANT	CH
	ARKEMA INC.	B,P,S		YOUNG'S FARMS	A
	BODYCOTE- GRAND RAPIDS	A		CITY OF LAPEER WWTP	CH
	BRETON IND'L PARK WAREHOUSE	B,S	LAPEER	GENESEE COUNTY WATER	CH
	CHASE STORAGE & CHASE ORCHARDS	A		LAPEER PLATING & PLASTICS	F
	COCA-COLA GRAND RAPIDS	A		MOLD MASTERS CO	S
	COUNTRY FRESH LLC	A	LENAWEE	ADC MAIN PLANT	MA,MMA,S
	DISTRIBUTION CENTER #1	A		AIRGAS USA LLC	A
	FINISHMASTER INC #990 DIST CR	S		DAIRY FARMERS OF AMERICA	A
	FORTY-FOURTH STREET FACILITY	F		NUTRIEN AG SOLUTIONS 634	A
	FRUIT RIDGE APPLE CO	A		WAR-AG FARMS HOME	A
	GM COMPONENTS HOLDINGS, LLC	A		WELLHOUSE #3 #9-12 & #14-15	CH
	GORDON FOOD SERVICE	A		WILBUR-ELLIS COMPANY - MUNSON	A
	GRANDVILLE	A		ASAHI KASEI PLASTICS NA	MA
	HEEREN LLC	A		BRIGHTON WATER	CH
	JACK BROWN PRODUCE INC	A	LIVINGSTON	CHEMCO PRODUCTS, INC.	F
	KENT QUALITY FOODS INC	A		COR-MET INC.	CO
	KING MILLING COMPANY	CH		GORDON FOOD SERVICE	A
	LACKS TRIM SYSTEM - AIRLANE PLANT	F		GREEN OAK DC	A
	LACKS WHEEL SYSTEMS	F		HOWELL WATER PLANT	CH
	LOWELL WWTP & WATER TREATMENT	CH		PEPSI HOWELL	A
	MICHIGAN NATURAL STORAGE CO	A	MACKINAC	THIRD STREET PUMP STATION	CH
	MICHIGAN TURKEY PRODUCERS	A		MACKINAC ISL WATER & WWTP	CH
	NBHX TRIM USA	S		ST IGNACE WATER PLANT	CH
	NORTH RIDGE ORCHARD	A	MACOMB	AXALTA COATING SYSTEMS	B,M,MMA,S
	PATTERSON ICE CENTER	A		BOSCOS PIZZA	A
	PLAINFIELD TWP WATER DEPT	CH		CARBIDE TECHNOLOGIES INC	A
	PLASTIC PLATE INC (KRAFT)	F		DEPOR SHELBY	B,F
	REMICO STREET FACILITY	F		EVERFRESH / LA CROIX BEVERAGES	A
	RIVERIDGE PACKING	A		EXCO EXTRUSION DIES INC	A
	ROSKAM BAKING CO-S1 & S2	A		FORMSPRAG LLC	A
	SPARTA FACILITY	A		GM GLOBAL TECHNICAL CENTER	A
	SPARTAN NASH DISTRIBUTION	A		METALLURGICAL PROCESSING CO	A
	STATE HEAT TREATING CO	A		NITRO-VAC HEAT TREATING	A
	SUPERIOR SEAFOOD INC.	A		NORBROOK PLATING	A
	SUPERIOR STONE PRODUCTS INC	MMA,S		REINHART FOODSERVICE LLC	A
	SYSCO GRAND RAPIDS, LLC	A		RIVIERA BUILDING 2	A
	THE HOME CITY ICE CO	A		SPECIALTY STEEL TREATING, INC.	A

Table 23, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
MACOMB	TURRI'S ITALIAN FOODS INC	A	OAKLAND	COMMERCIAL STEEL TREATING	A
MARQUETTE	KI SAWYER WWTP	CH		DEPOR INDUSTRIES	B,F
MASON	HOUSE OF FLAVORS INC	A		DETROIT SKATING CLUB	A
	JOS SANDERS INC	A		ENGINEERED HEAT TREAT INC	A
	LUDINGTON WASTEWATER PLANT	CH		FARMINGTON HILLS ICE ARENA	A
	MICHIGAN FOOD PROCESSORS	A		GENERAL MOTORS - PROVING GD	CH
MECOSTA	AGCO, INC-REMUS DIVISION	S		INTERNATIONAL PAINT LLC	S
	ICE MTN NATURAL SPRING WATER	A		JOHN LINDELL ICE ARENA	A
	LEPRINO FOODS COMPANY REMUS	A		LAKELAND ARENA	A
MENOMINEE	L.E. JONES COMPANY	CO		MACDERMID INCORPORATED	F
	MENOMINEE WATER & WWTP	CH		MAHLE BEHR AMERICA INC	A
	RULEAU BROTHERS INC	A		MATHESON WIXOM	A
MIDLAND	CITY OF MIDLAND - WATER & WWTP	CH		OERLIKON	A
	CPI FLUID ENGINEERING	F		SPECIALTY STEEL TREATING INC	A
	DOW AGROSCIENCES LLC	A,CH		STONE SOAP COMPANY INC	F
	DOW SILICONES CORP- MIDLAND	A,CH		SUBURBAN ICE ROCHESTER	A
	DUPONT MICHIGAN OPERATIONS	A		SULZER METCO (US) INC	CO
	MIDLAND STORE	A		SUN STEEL TREATING INC	A
	SK SARAN	A,M		US FOODS INC.	A
	TRINSEO, LLC MICHIGAN OPS	MMA,S		VILLAGE OF HOLLY WWTP	CH
MONROE	ADVANCED HEAT TREAT CORP	A		WATERFORD IRON REMOVAL 5-1, 12-1,	CH
	HOME CITY ICE COMPANY- TOLEDO	A		14-1, 16-1 & 2, MS-1, 19-1, 24-1, 25-1 & 2, 28-	
	INDEPENDENT DAIRY INC	A		1,31-1	
	MEIJER NEWPORT DISTRIBUTION	A		WOODWORTH INC PONTIAC	A
	MILAN WATER TREATMENT PLT	CH	OCEANA	2ND STREET STORAGE	A
	MONROE POWER PLANT	A		ARBRE FARMS CORPORATION	A
	OTTAWA LAKE CO-OP ELEVATOR	A		MICHIGAN FREEZE PACK	A
MONTCALM	WILBUR-ELLIS CO LLC- EDMORE	A		OCEANA CTY FREEZER STORAGE	A
MUSKEGON	BASF CORP	A		PETERSON FARMS MAIN CAMPUS	A
	COLE'S QUALITY FOODS, INC.	A	OGEMAW	HYPERION MATERIAL AND TECH	CO
	HOWMET CORP - PLT 10	B	OSCEOLA	ADVANCED FIBERMOLDING	S
	L-3 HARRIS COMBAT PROPULSION SYS	A		VENTRA EVART, LLC	F
	MUSKEGON COMPOSITES INC	S		YOPLAIT REED CITY	A
	PARAMELT (M. ARGUESO)	B	OTSEGO	ALBIE'S FOODS	A
	SNAPPY APPLE FARMS INC	A		GAYLORD	CH
	SUN CHEMICAL CORPORATION	A	OTTAWA	ALLENDAL PLANT	A
	WEBB CHEMICAL SERVICE CORP	F		BOAR'S HEAD PROVISIONS CO INC	A
NEWAYGO	GERBER PRODUCTS COMPANY	A		CREME CURLS BAKERY, INC.	A
	RICE LAKE FARMS PACKAGING LLC	A		DIETRICH ORCHARDS	A
OAKLAND	CHEMICAL BLENDING	MMA		GOOD FRUIT STORAGE LLC	A
	CHOR INDUSTRIES	A		HOMESTEAD ORCHARDS STORAGE	A

Table 23, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
OTTAWA	HUDSONVILLE PLANT	A	VAN BUREN	DECATUR	A
	JOHN F. DONNELLY PLANT	A		GRAND JUNCTION FACILITY	A
	MEAD JOHNSON AND CO LLC	CH		HARTFORD WAREHOUSE	A
	MICHIGAN CELERY PROMOTION	A		HONEE BEAR CANNING	A
	MICHIGAN NATURAL STORAGE	A		IQF FACILITY	A
	POLYPLY COMPOSITES LLC.	S		LAWRENCE FREEZER CORP.	A
	QUINCY STREET, INC	A		MINS PAW PAW LOGISTIC CENTER	A
	SUPERIOR SALES INC	A		PAW PAW PLANT	A
	VERTELLUS ZEELAND LLC	MA		PAW PAW RIVER PRODUCE	A
	ZEELAND FACILITY	A		SHAHER LAKE FRUIT, INC	A
	ZEELAND FARM SERVICES, INC	A		SHAWSA WWTP	CH
SAGINAW	ADVANCED MICRONUTRIENT PRODUCTS	A	WASHTENAW	SILL FARMS MARKET, INC	A
	BRIDGEPORT WWTP	CH		ST. JULIAN WINE COMPANY INC	A
	BUENA VISTA WWTP	CH		WELCH FOODS, INC.	A
	FRANKENMUTH CITY OF WATER & WWTP	CH		ANN ARBOR, CITY OF WTP	A
	HEALTH CARE IND MATERIAL SITE	A		ANN ARBOR ICE CUBE	A
	HI-TECH STEEL TREATING, INC.	A		ARBOR HILLS ENERGY LLC	A
	NEXTEER AUTOMOTIVE	A		ARCTIC GLACIER INC	A
	SAGINAW TWP RETENTION BASIN	CH		DAPCO INDUSTRIES	A
SANILAC	UMBRA GROUP, LINEAR MOTION LLC	A	WAYNE	LOCH ALPINE SANITARY AUTH	CH
	WWTP, SAGINAW CHARTER TWP	CH		NUTRIEN AG SOLUTIONS 881	A
	DGP INCORPORATED	S		UNIVERSITY OF MICHIGAN	A
SHIAWASSEE	MIDWEST RUBBER CO.	CH		A&R PACKING CO INC	A
	AIRGAS SPEC PRODUCTS	A		ARCTIC EDGE ICE ARENA	A
	CIE NEWCOR MFG-PLANT 1	A		BASF CORPORATION	MMA, S
ST CLAIR	HARVEST MILLS	A		BODYCOTE ROMULUS	A
	DUNN PAPER, INC.	CH		BODYCOTE THERMAL PROCESSING	A
	LK HURON WATER TREATMENT	CH		C. F. BURGER CO	A
	PORT HURON	A		CANTON	A,F
ST JOSEPH	Z F MARYSVILLE AXLE DRIVES	A		CANTON RENEWABLES	A
	ABBOTT NUTRITION - STURGIS	A		CARDINAL HEALTH	F
	AQUATIC CO.	S		CHAMPION FOODS	A
	MICHIGAN MILK PRODUCERS	A		CLASSIC PLATING	A
	NUTRIEN AG SOLUTIONS 635 & 641	A		COOPER HEAT TREATING LLC	A
	STURGIS WWTP	CH		COSTCO WHOLESALE	A
	THREE RIVERS WWTP	CH		COUNTRY FRESH, LLC - LIVONIA	A
TUSCOLA	CARO WWTP	CH	VAN BUREN	CREST INDUSTRIES INC	S
	CASS CITY WWTP	CH		DEARBORN ICE SKATING CENTER	A
	FARM DEPOT	S		DETROIT PRODUCTION CENTER	A
VAN BUREN	ALBEMARLE CO S HAVEN	A		DBA ALDOA COMPANY	E, F
	ALLOY STEEL TREATING CO INC	A		DRDC	M
	COCA-COLA N AMERICA	A		DYNAMIC SURFACE TECH INT'L	A

Table 23, continued...

COUNTY	COMPANY NAME	EXPOSURE	COUNTY	COMPANY NAME	EXPOSURE
WAYNE	FAYGO BEVERAGES	A	WAYNE	SYSCO DETROIT, LLC	A
	FCA US LLC-JEFFERSON PLANT	E, F		TRENTON CHANNEL POWER PLANT	A
	FISHER BUILDING	A		TRENTON, CITY OF WWTP	CH
	FREEZER SERVICES OF MI LLC	A		UNIVAR USA—ROMULUS	MA
	FRITZ PRODUCTS	CH		USA HOCKEY ARENA	A
	HOME CITY ICE CO - DETROIT	A		WATER RESOURCE RECOVERY FAC- DETROIT	CH
	INLAND WATERS POLL'N CONTROL INC	S		WATER WORKS PARK PLANT-DETROIT	CH
	JCI JONES CHEMICALS INC.	CH		WOLVERINE PACKING CO DISTRIBUTION PLANT	A
	LINCOLN DISTRIBUTING	S		WOLVERINE PACKING CO-FOREST PK	A
	MASTRONARDI PRODUCE	A		YACK ARENA	A
	MCLANE FOOD SERVICE - PLYMOUTH	A	WEXFORD	FOUR WINNS-CRUISER DIVISION	MMA, S
	MICHIGAN DAIRY	A		FOUR WINNS-SPORT DIVISION	S
	NORTHEAST WATER PLANT	CH		HARING TOWNSHIP WATER SUPPLY	CH
	PEPSI BOTTLING GROUP	A			
	PLYMOUTH	CO			
	POLYCHEMIE INC	F			
	PRAXAIR DISTRIBUTION INC	A,CH			
	PROGRESSIVE DISTRIBUTION CTRS	B,E,MMA,S			
	PVS TECHNOLOGIES, INC.	CH,F			
	SHERWOOD FOOD DISTRIBUTORS LLC	A			
	SOUTHWEST WATER PLANT	CH			
	SPRINGWELLS WATER TREATMENT PLT	CH			

Source: Michigan Department of Environment, Great Lakes, and Energy (EGLE). Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting, December 2007, 6th edition. The chemicals listed in this table are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313, which is triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at facilities in Michigan. The companies listed in this table were current as of calendar year 2020 from a report generated by the Michigan EGLE on 11/29/2021.

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 except for 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. We will be able to assess other exposures more fully in next year's annual report when the 2020 data should be more complete, and with the addition of the 2021 cases.

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) released a consensus statement in 2003 that estimates in 15% of adults with asthma, the asthma is caused by work

exposures.⁶ In 2011, 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 2.1 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.

As companies trim costs, 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 (13.0%), isocyanates (11.8%) and metal working fluids (8.8%). 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

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

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). In a move that will provide even greater information about the ingredients of cleaning agents, New York State has promulgated a rule that covers all soaps and detergents sold in New York that contain a surfactant as a wetting or dirt emulsifying agent and are used primarily for domestic or commercial cleaning purposes, including but not limited to the cleansing of fabrics, dishes, food utensils and household and commercial premises. The rule required manufacturers to list ingredients intentionally added to cleaning products on their web page, that are present above trace quantities, by July 1, 2019. Fragrance and nonfunctional ingredients, such as byproducts and contaminants, must be disclosed by July 1, 2020.

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.

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 2,421 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 develops WRA. About 44% of the WRA patients identified through the Michigan Tracking System have no personal or family history of allergies and 80% 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 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 Injury and Illness Log (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. We will continue to examine the utility of this new data source in 2021.

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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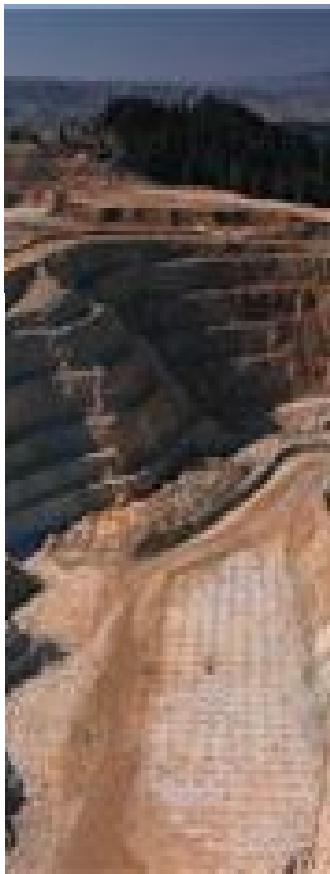
APPENDIX

2020 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.

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MANUFACTURING

Exposure to isocyanates

OA4298. A male in his 50s developed work-related asthma after exposure to isocyanates while working as a mixer operator for a company that manufactures silicones. He developed a cough and shortness of breath and sought medical treatment in the emergency department. He was prescribed Albuterol and Advair. He was off work because of his breathing problems but recently returned to work. He was a lifelong non-smoker.

Exposure to metal working fluids and welding fume

POA4372. A male in his 60s developed work-related asthma from exposure to metal working fluids and welding fume at a manufacturing facility. He was prescribed Spiriva and Pulmicort. He retired two years after his diagnosis; since then, his asthma has worsened, and he requires a greater amount of asthma medication. He was a lifelong non-smoker. On spirometry, FVC was 95% of predicted, and FEV1 was 88% of predicted.

Exposure to cleaning agents

POA4344. A female in her 50s developed work-related asthma from exposure to cleaning parts at a battery manufacturer. She had worked at the facility for less than a year. She developed wheezing, cough, shortness of breath and chest tightness. She sought treatment at an emergency department. She was prescribed Prednisone. After her diagnosis, she was reassigned to a job not involving cleaning. Since then, her asthma has worsened, and she still requires asthma medication. She formerly smoked a half pack of cigarettes per day, from her mid-teens to her early 40s.

Exposure to miscellaneous chemicals and dusts

POA4294. A male in his 60s developed work-related asthma after exposure to dusts while working as a machine operator in an auto parts manufacturing plant. He developed shortness of breath and wheezing and sought medical treatment in the emergency department. He was prescribed Albuterol inhaler, and a nebulizer. He formerly smoked an average of 20 cigarettes a day for 34 years. He was fired and is no longer exposed.

POA4357. A male in his 20s developed work-related asthma while working in the paint department at an automotive and non-automotive parts manufacturer. Shortly after he began working there, he developed wheezing, cough, chest tightness and shortness of

breath. He was prescribed Symbicort. Approximately two years after his asthma developed, he was placed on sick leave. Since then, his asthma has worsened although he takes less asthma medication. He formerly smoked a pack of cigarettes per day for six years from his mid-20s to his early 30s.

AA4351. A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to fumes at a stamping plant. She experienced wheezing and shortness of breath. She sought treatment in an emergency department. She was prescribed Albuterol. She was a current half pack a day cigarette smoker.

AA4345. A female in her 30s experienced an exacerbation of her pre-existing asthma when she was exposed to truck exhaust at an auto manufacturing facility. She experienced chest tightness and shortness of breath. She was prescribed a nebulizer and an Albuterol inhaler. She did not normally work in the area where there was truck exhaust.

POA4343. A female in her 50s developed work-related asthma when she was moved to a job running a CNC machine at an auto parts manufacturer. Prior to this, she had worked at the facility for five years in a temperature-controlled room, with no breathing symptoms. She developed wheezing, cough, shortness of breath and chest tightness. She was prescribed Albuterol, Breo and Spiriva. She was awarded workers' compensation approximately one year after her diagnosis and has not worked since that time. Her asthma worsened, and she requires a greater amount of asthma medication. She formerly smoked five cigarettes a day for five years from her mid-teens to her early 20s.

POA4293. A male in his 40s developed work-related asthma at an auto manufacturing facility where he was exposed to glue. He developed wheezing, cough and shortness of breath within a year of beginning work. He was prescribed Albuterol, Pulmicort, Prednisone and Qvar. After his diagnosis, he was reassigned to a new location at the facility. Since then, his asthma has persisted, and he still requires asthma medication. He smoked an average of a pack of cigarettes per day.

POA4306. A male in his 60s developed work-related asthma after exposure to fire extinguisher powder while working as a supervisor in a metal tubing manufacturing plant. He developed a cough, wheezing, chest tightness, and shortness of breath and sought medical treatment. He was prescribed Albuterol and Benzonatate. He formerly smoked an average of 20 cigarettes a day for 43 years.

AA4316. A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to cleaning chemicals while working in an auto parts manufacturing plant. She developed shortness of breath and sought medical treatment in the emergency department. She was prescribed Advair, Symbicort, Prednisone, and DuoNeb. She was a lifelong non-smoker.

AA4323. A male in his 50s experienced an exacerbation of his pre-existing asthma after exposure to phosphate while working for an auto parts manufacturer. He developed wheezing and shortness of breath and sought medical treatment in the emergency department. He was prescribed Albuterol. He was an ex-smoker.

POA4326. A male in his 30s developed work-related asthma after exposure to flux while working for an auto parts manufacturer. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment. He was prescribed Ventolin. He was an ex-smoker.

AA4334. A female in her 50s experienced an exacerbation of her pre-existing asthma after exposure to dust while working for a plastic parts manufacturer. She developed shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. She was a current smoker and smoked an average of 10 cigarettes per day.

AA4339. A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to a chemical cleaner while working for an auto parts manufacturer. She developed chest tightness and shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. She was a current smoker and smoked an average of 10 cigarettes per day for seven years.

POA4289. A male in his 20s developed work-related asthma after exposure to steel grinding and paint fumes while working in a fabrication shop as a welder. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed an oral steroid. He was a lifelong non-smoker.

AA4324. A male in his 20s experienced an exacerbation of his pre-existing asthma after exposure to machine fumes while working for an auto parts manufacturer. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed Floair and an oral steroid. He was a lifelong non-smoker.

AA4336. A female in her 30s experienced an exacerbation of her pre-existing asthma after exposure to paint fumes while working in an auto parts manufacturing plant. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. She was reassigned and no longer works near the paint department. She formerly smoked an average of 20 cigarettes a day for 20 years.

Miscellaneous

AA4299. A female in her 30s experienced an exacerbation of her pre-existing asthma after having to wear a mask due to COVID-19 while working as a parts operator for an auto manufacturing plant. She developed shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. She was a lifelong non-smoker.

EDUCATIONAL SERVICES

Exposure to cleaning products including disinfectants

POA4328. A female in her 40s developed work-related asthma after exposure to cleaning chemicals while working as a custodian for a school district. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. She no longer works this job. She was a current smoker and smoked an average of 10 cigarettes a day for 10 years.

AA4344. A female teacher in her 50s experienced an exacerbation of her pre-existing asthma at the elementary school where she taught for five years after she was exposed to a disinfectant fogger applied throughout the school during the COVID-19 pandemic. There was not supposed to be anyone in the building during fogging. The janitor applying the disinfectant was wearing a Hazmat suit. She experienced chest tightness and shortness of breath. She sought treatment at the emergency department. Since the incident, she was transferred to another school. Her asthma has worsened, and she requires a greater amount of asthma medication. She was a lifelong non-smoker.

OA4342. A female elementary school teacher in her 30s developed work-related asthma from exposure to disinfectants used to clean the school during the COVID-19 pandemic. She had worked at the school for three years. She developed wheezing, a cough, shortness of breath and chest tightness. Her symptoms only occurred when she was in the school building when cleaning was performed. She was prescribed an albuterol inhaler. She continued to be exposed to disinfectants when fellow teachers clean near her room. Since her diagnosis, her asthma has improved, although she requires a greater amount of asthma medication. She was a lifelong non-smoker.

Exposure to air contaminants

POA4320. A female in her 50s developed work-related asthma after exposure to a moldy shipment of lab equipment while working as a lab manager in a university. She developed a cough, chest tightness, and shortness of breath and sought medical treatment. She was prescribed Dulera, Spiriva, and Dupixent. She no longer works this job. She was a lifelong non-smoker.

HEALTH CARE SERVICES

Exposure to disinfectants

AA4283. A female in her 30s experienced an exacerbation of her pre-existing asthma after exposure to cleaning products from COVID-19 sanitizing while she was working as a receptionist at a medical center. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment. She was prescribed Prednisone. She was fired from this job and is no longer exposed. She was a lifelong non-smoker.

OA4295. A female in her 50s developed work-related asthma after exposure to cleaning chemicals while working as a medical assistant in a pediatric clinic. She was cleaning more often with disinfectants due to COVID-19. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. She was prescribed Advair and Albuterol. She was a lifelong non-smoker.

OA4297. A female in her 60s developed work-related asthma after exposure to cleaning chemicals while working as a janitor in a hospital. She developed a cough and wheezing and sought medical treatment in the emergency department. She was prescribed Albuterol, Prednisone, and an inhaler. She formerly smoked an average of 10 cigarettes per day for 44 years.

RADS4292. A female janitor at a hospital in her 60s developed RADS from exposure to bleach during cleaning. She developed a cough and shortness of breath. She was prescribed an albuterol inhaler. She was reassigned to clean rooms that did not require bleach. She was a lifelong non-smoker. On spirometry, FVC was 88% of predicted, FEV1 was 96% of predicted and FEV1/FVC was 107% of predicted.

Exposure to other cleaning products

AA4291. A female hospital worker in her 40s experienced an exacerbation of her pre-existing asthma when she was exposed to floor strippers and waxers at work. She developed a cough, shortness of breath and chest tightness. She was prescribed Albuterol and a steroid. Since then, she avoids being in the areas where floors are being cleaned.

Exposure to indoor air contaminants and miscellaneous chemicals and dust

AA4303. A female in her 30s experienced an exacerbation of her pre-existing asthma after exposure to seafood, while working as a nurse in a hospital. She developed wheezing and shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. She was a lifelong non-smoker.

POA4327. A female in her 50s developed work-related asthma after exposure to printer ink and powder while doing office work in a hospital. She developed chest tightness and shortness of breath and sought medical treatment. She was prescribed Qvar and Singulair. She was a lifelong non-smoker.

WHOLESALE AND RETAIL SERVICES

Exposure to miscellaneous chemicals and dust

AA4277. A male in his 20s experienced an exacerbation of his pre-existing asthma after exposure to battery acid fumes while driving a forklift for a retail store. He developed a cough, chest tightness, and shortness of breath and sought medical treatment in the emergency department. He was prescribed Albuterol. He was a lifelong non-smoker.

POA4304. A male in his 40s developed work-related asthma after exposure to cleaning chemicals during COVID-19 while working in an electronics retail store. He developed shortness of breath and sought medical treatment in the emergency department. He was prescribed Prednisone. He is no longer exposed as they now use a new cleaning product. He was a lifelong non-smoker.

AA4317. A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to cleaning chemicals while working in retail. She developed a cough and shortness of breath and called poison control for medical advice.

OA4348. A male in his 30s developed work-related asthma from exposure to soybean dust at a grain elevator where he worked operating and maintaining grain/mill equipment. He worked six years before he developed wheezing, cough and shortness of breath. He was prescribed Albuterol and Prednisone. Following the advice of his doctor, he quit this job one year after his diagnosis. Since then, he found new employment. His asthma symptoms have remained the same, despite larger doses of asthma medication. He formerly smoked a pack of cigarettes per day for five years from his mid-teens to his early 20's.

OFFICE/INDOOR AIR

Exposure to cleaning agents

OA4353. A female in her 60s developed work-related asthma from exposure to disinfectants. She was a business manager for 10 years for a church. When the COVID-19 pandemic occurred, the cleaning company at her work started using different cleaning chemicals. Within a month of the new cleaning protocol, she developed a cough, chest tightness and shortness of breath. She was prescribed an oral steroid and a rescue inhaler. With the onset of her work-related asthma, the cleaning company changed the cleaning chemicals used. Since then, her asthma has improved, and she requires less medication. She was a lifelong non-smoker.

Exposure to indoor air contaminants

AA4329. A female in her 50s experienced an exacerbation of her pre-existing asthma after exposure to molds and mildews while working in an old courthouse as a case manager. She developed shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol and Spiriva. She quit this job because of her asthma. She formerly smoked an average of seven cigarettes a day for 38 years.

CONSTRUCTION

Exposure to miscellaneous chemicals and dust

RADS4338. A male in his 50s developed RADS after exposure to cement dust while installing flooring. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed Albuterol and Prednisone. He was a lifelong non-smoker.

FOOD SERVICE

Exposure to miscellaneous substances

AA4290. A male in his 40s experienced an exacerbation of his pre-existing asthma after exposure to smoke while working as a cook in a restaurant. He developed wheezing and shortness of breath and sought medical treatment in the emergency department. He was prescribed Prednisone and an inhaler. He was a current smoker and smoked an average of 15 cigarettes per day for the past 20 years.

AA4325. A male in his 40s experienced an exacerbation of his pre-existing asthma after exposure to carbon dioxide and nitrogen gas after a keg was tapped incorrectly at the bar where he worked. He developed a cough, chest tightness, and shortness of breath and sought medical treatment in the emergency department.

POA4340. A female in her 40s developed work-related asthma after exposure to smoke while working in a restaurant. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. She was prescribed Prednisone, Pulmicort, Albuterol, Wixela, Montelukast, and Doxycycline. She quit this job because of her breathing problems. She was a lifelong non-smoker.

PUBLIC SERVICES

Exposure to miscellaneous substances

AA4313. A female firefighter in her 30s experienced an exacerbation of her pre-existing asthma after exposure to the solution used to perform respirator fit testing. She developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. She was prescribed an oral steroid and an inhaler. She was a lifelong non-smoker.

MISCELLANEOUS SERVICES AND INDUSTRIES

Exposure to cleaning products including disinfectants

AA4282. A female in her 30s experienced an exacerbation of her pre-existing asthma after exposure to a disinfectant while working for a restoration company. They were using extra disinfectant because of COVID-19. She developed a cough, wheezing, chest tightness, and shortness of breath and sought medical treatment. She was prescribed steroids and Albuterol. She formerly smoked an average of four cigarettes per day for four years. She was laid off due to COVID-19 and was no longer exposed.

AA4311. A female in her 40s experienced an exacerbation of her pre-existing asthma after exposure to cleaning chemicals while working for a cleaning company. She developed a cough, wheezing, chest tightness, and shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol and Symbicort. She currently smoked an average of 10 cigarettes a day for the past 30 years.

AA4314. A male in his 40s experienced an exacerbation of his pre-existing asthma after exposure to cleaning chemicals while working in a food processing plant drying fruit. He developed a cough, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed an inhaler. He currently smoked an average of four cigarettes a day for the past 31 years.

Exposure to isocyanates

OA4296. A male in his 20s developed work-related asthma while working in a auto repair shop. He used an isocyanate-containing glue to replace windshields. He developed a cough, chest tightness and shortness of breath. He was a lifelong nonsmoker. On spirometry, FVC was 85% of predicted, FEV1 was 83% of predicted and FEV1/FVC was 81% of predicted.

Exposure to miscellaneous substances

AA4302. A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to chemicals while working for an auto body detailing company. She developed a cough and chest tightness and sought medical treatment in the emergency department. She was prescribed Prednisone. She was a lifelong non-smoker but had a history of vaping.

AA4300. A male painter in his 40s experienced an exacerbation of his pre-existing asthma after exposure to paint fumes. He developed a cough and chest tightness and sought medical treatment in the emergency department. He was prescribed Albuterol. He had a history of smoking.

OA4305. A male in his 40s developed work-related asthma after exposure to isocyanates while painting cars in an auto shop. He developed a cough, wheezing, chest tightness, and shortness of breath and sought medical treatment. He was prescribed Albuterol. He no longer works with isocyanates or does painting. He formerly smoked an average of 10 cigarettes a day for 24 years.

AA4319. A male in his 20s experienced an exacerbation of his pre-existing asthma after exposure to aluminum dust while working as a mechanic in an auto shop. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed Albuterol. He was a lifelong non-smoker.

OA4321. A male in his 40s developed work-related asthma after exposure to isocyanates while working in an auto body shop. He developed a cough, chest tightness, wheezing, and shortness of breath and sought medical treatment in the emergency department. He was prescribed Singulair. He was a lifelong non-smoker.

AA4332. A female in her 20s experienced an exacerbation of her pre-existing asthma after exposure to methane while working at a hair salon. She developed chest tightness and shortness of breath and sought medical treatment in the emergency department. She was prescribed Albuterol. The hair salon fixed the leak after she filed for workers' compensation. She was a lifelong non-smoker.

POA4307. A male in his 60s developed work-related asthma while working at a casino resort. He was prescribed Advair.