

1998

Annual Report on Work-Related Asthma in Michigan



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A Joint Report
of the
Michigan State University
Department of Medicine
117 West Fee Hall
East Lansing, Michigan 48824-1316
(517) 353-1846
Kenneth D. Rosenman, MD
Professor of Medicine
Mary Jo Reilly, MS
Epidemiologist

and

the Michigan Department
of Consumer & Industry Services
P. O. Box 30195
Lansing, Michigan 48909
(517) 335-8250
Bureau of Safety and Regulation
Douglas J. Kalinowski, CIH
Deputy Director

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Summary:

This is the eighth annual report on work-related asthma in Michigan. An average of 143 new people each year are reported to the Michigan Department of Consumer and Industry Services (MDCIS) with asthma caused by work. Based on 1996 data, the reports received by the Michigan Department of Consumer and Industry Services represent 18.8%-66.7% of the number of estimated people in Michigan who develop work-related asthma each year. Inspections at the workplaces of these individuals reveals a large number of fellow workers with asthma or respiratory symptoms compatible with asthma. The work exposures may cause new onset asthma from exposure to an allergen or an irritant that precipitates inflammatory changes, or work exposures may exacerbate pre-existing asthma from exposure to an irritant. Ninety percent of the reports received involve the new onset of asthma.

Known allergens such as isocyanates and metal working fluids are the most common cause of work-related asthma in Michigan. Despite the association of a patient's asthma with work, many times a known allergen is not identified. Practitioners need to maintain a high level of clinical suspicion for new causes of work-related asthma.

Work-related asthma is affecting men and women, generally in their 30s - 50s. Exposures are occurring in a wide range of workplaces. When an inspection is conducted at the workplace, significant numbers of symptomatic individuals have been identified. However, air monitoring at these same facilities typically reveals that the exposures to the suspected allergen or irritant are within existing workplace standards. Often a specific workplace standard for the suspected allergen or irritant does not exist.

Reevaluation of existing work standards for some exposures including isocyanates is needed. Federal OSHA is continuing to consider lowering the exposure standard for metal working fluids. The past year we summarized 56 reports of work-related asthma received that were attributed to cleaning products. Further work is needed to elucidate measures to prevent asthma from occurring among individuals who use these products.

Background:

Based on extrapolation from national estimates there are approximately 230,000 adults with asthma in Michigan (2). It is estimated that work place exposures are responsible for asthma in 2 - 33% of adults (3-10). A Michigan study estimates that workplace exposures are possible contributing causes to the development of asthma in 3 -26% of adults hospitalized with asthma in Michigan (6).

In 1988, the Michigan Department of Consumer and Industry Services (formerly the Michigan Department of Public Health) instituted a surveillance program for work-related asthma with financial assistance from the National Institute for Occupational Safety and Health (NIOSH). The goal of the surveillance program is to prevent work-related disease through the reporting of index patients. The reporting of the index patient is regarded as a sentinel health event that may lead to the identification of other employees from the same facility who are at risk of developing or who have developed similar breathing problems. There are three sources used to identify persons with work-related asthma: reports from physicians; reports from hospitals (since 1989); and claims filed since 1988 with the Bureau of Workers' Compensation. Both physicians in private practice and those working for industry send reports to the Michigan Department of Consumer and Industry Services (MDCIS). Reports from hospitals are requested once each year. Hospital discharge summaries for individuals with a primary or secondary diagnosis of a respiratory condition due to chemical fumes and vapors (ICD-9 506.0-9) as well as individuals with a primary or secondary diagnosis of asthma (ICD-9 493) where the principal payer is listed as workers' compensation are obtained from the Michigan Health and Hospital Association's (MHA) Michigan inpatient database to verify the completeness of reporting by the hospitals, and the work-relatedness of the condition is determined.

A person is considered to have occupational asthma from sensitization to a workplace exposure if: A) they have a physician diagnosis of asthma, and B) onset of respiratory symptoms associated with a particular job that then improve or are relieved when the patient is not working, and C) they work with a known occupational allergen, or have evidence of an association between work exposures and a decrease in pulmonary function testing.

Additional criteria are used to record three other categories of asthma associated with work. If only criteria (A) and (B) above are met the person is considered to have possible occupational asthma. An industrial hygiene investigation at the patient's work site is performed to determine the allergen. If a person had physician-diagnosed asthma before beginning work and their asthma became worse at a particular job the person is considered to have aggravated asthma. Occupational asthma from exposure to an allergen at work typically develops after a variable period of symptomless exposure to the sensitizing agent. However, if a person develops asthma for the first time immediately after an acute exposure to an irritating chemical at work the patient is considered to have Reactive Airways Dysfunction Syndrome (RADS) (11).

After the patient has been interviewed and the work-relatedness of their condition evaluated, an industrial hygiene investigation may be conducted at the patient's workplace. At this follow-up investigation, co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure to the suspected allergen. An industrial hygienist conducts air monitoring for any suspected allergens and reviews the company's health and safety program. After the investigation is completed, a report of air sampling results and any recommendations are sent to the company and union (or designated labor representative, if the company does not have a union).

In 1998, we also began sending letters about potential problems with exposures to some of the companies where the index cases were exposed to an allergen, in cases where a formal MIOSHA inspection was not planned. These letters, in lieu of inspections, are sent to the company health and safety director, and ask the company to evaluate exposures to whatever suspected allergens were identified through our interview with the index case.

Results:

Reports

Table 1 shows that 1336 people were confirmed with work-related asthma between 1988 - 1998. Figure 4 presents the same data in a bar graph of the number of cases identified each year, and the types of work-related asthma that were confirmed. The reports are divided into four categories: occupational asthma, possible occupational asthma, aggravated asthma and RADS. One hundred fifty-seven additional patients have been confirmed since last year's report. There were 31 confirmed reports in 1988, 63 in 1989, 144 in 1990, 114 in 1991, 150 in 1992, 176 in 1993, 152 in 1994, 127 in 1995, 152 in 1996, 132 in 1997; and 95 in 1998. Figure 1 shows the overlap of the 1241 patients by reporting sources for 1988-1997.

The data is incomplete for 1988 since the surveillance system was initiated in that year. To date we have not yet received complete hospital reporting for 1997 and 1998, and patient interviews are still needed for 9 reports of patients from hospitals and 1 report of a patient from a physician in 1997; and, 36 reports of patients from physicians in 1998.

Gender

Six hundred seventy (50.1%) of the persons with work-related asthma are women and 666 (49.9%) are men.

Race

One thousand twenty-two (76.7%) of the persons with work-related asthma are white, 250 (18.8%) are African American, 34 (2.6%) are Hispanic, 11 (0.8%) are Alaskan or American Indian, 5 (0.4%) are Asian and, 11 (0.8%) were listed as "other." Race was unknown for 3 individuals.

Age

The dates of birth range from 1905 - 1976. The average year of birth is 1951.

Location in State

Figure 2 shows the county in which the patient worked where they developed work-related asthma. The main locations are: Wayne (378 cases, 28.6%), Oakland (178 cases, 13.5%), and Macomb (131 cases, 9.9%). Table 2 and Figure 3 show the annual average incidence rates of work-related asthma among the general working population in each county. Based on the annual average incidence of reports of confirmed cases per 100,000 adult workers, Luce (24.1 per 100,000) and Clare (10.9 per 100,000) have the highest rates. Table 3 shows the annual incidence rates for the larger metropolitan areas and the whole state for the years 1990 through 1996 separately.

Type of Industry

Table 4 shows the types of Michigan industries where the exposures to the occupational allergens occurred from 1988 to 1998. Figure 5 shows the distribution of major industry types for all cases identified from 1988-1998. The predominant industries for the total number of cases identified between 1988 and 1998 were in the manufacturing sector: automobile (42.8%), industrial and commercial machinery and computer equipment (4.1%), foundries (3.4%), fabricated metal products (4.7%), and rubber and miscellaneous plastic products (4.3%). Workers in the health field also accounted for a high percentage of the total number of patients (8.3%).

The incidence rate of work-related asthma by industry type ranges from 0.3 cases per 100,000 in agriculture, to a high of 20.8 cases per 100,000 in the manufacture of transportation equipment. The industries with the highest annual average incidence rates besides the manufacture of transportation equipment included: foundries with 13.9 cases per 100,000 workers; the manufacture of rubber products with 11.1 cases per 100,000 workers and the manufacture of other nondurables with 11.3 cases per 100,000 workers.

Table 5 shows the annual incidence rates for the 1990 through 1996 work-related cases within those industries which had 20 or more reports.

Overall, by broad industrial classification, there were 13.3 cases per 100,000 workers in the manufacturing industry; 3.3 cases per 100,000 workers in the construction and mining industry; and 1.3 cases per 100,000 workers in the service producing industry.

Table 6 shows the predominant exposures causing work-related asthma in Michigan. The most frequent exposures were to isocyanates (19.1%), metal working fluids (12.2%), vehicle exhaust (5.5%), welding fumes (4.9%), and solvents (3.1%). The agent has not yet been identified for 179 patients (13.4%). The exposures to unknown agents occurred 92 times in the manufacturing sector and 87 times in an office setting.

Medical Results

Table 7 shows patients' cigarette smoking status. Almost 20% of patients were smoking when their work-related asthma developed. This is a lower percentage than typically found in a blue collar working population.

Over forty percent of the work-related asthma patients had a family history of allergies (Table 8).

Forty-five percent of the asthma patients had a personal history of allergies or asthma (Table 9). Two hundred fifty-seven (42.1%) of the 611 patients with a personal history of allergies or asthma previously had asthma.

One thousand eighty-three of the patients identified with work-related asthma had persistence of their asthma symptoms (Table 10). This was true for 373 of 390 (95.6%) of those still exposed as well as 710 of 860 (82.6%) no longer exposed to the substance causing their asthma. Among those no longer exposed, 50.6% stated their symptoms were less severe compared to 35.4% among those still exposed who reported their symptoms were less severe. Similarly, 84.4% of those still exposed were continuing to take asthma medications while 75.1% of those no longer exposed were still taking asthma medications. Among those no longer exposed, 31.2% stated they were taking fewer medications while only 22.1% of those still exposed were taking fewer medications (Table 10).

Five hundred seventy-eight of 1232 (46.9%) patients with known workers' compensation status had applied for workers'

compensation. Cases were pending for 282 (48.8%) of those who applied, while 206 (35.6%) had received awards and 90 (15.6%) had been denied.

Industrial Hygiene

The 1336 people with work-related asthma worked at 888 different facilities. Inspections were performed at 430 (46.0%) of these facilities. Fifty-eight inspections were completed since last year's report. Inspections are scheduled at 6 (0.6%) facilities (Table 11). In addition, because of inadequate resources to conduct inspections at all the identified facilities, 45 facilities received letters notifying them that a disease report had been received and asking them to investigate potential exposures causing the respiratory problem, including indoor air problems.

Air sampling for allergens was conducted during 285 of the inspections. Thirty-five of the 285 (12.3%) facilities were above the National Institute for Occupational Safety and Health recommended exposure limit (REL). Nineteen of the 285 (6.7%) were above the enforceable Michigan Occupational Health and Safety Administration (MIOSHA) permissible exposure limit (PEL) (Table 12).

Interviews of fellow workers were performed at 322 of the 430 inspections. Workers had daily or weekly breathing symptoms in 230 of the 322 (71.4%) companies. The average percentage of workers with symptoms in these 230 companies was 21.9%, ranging from 2% to 100%. Interviews conducted in 92 companies found no co-workers with symptoms. One thousand ninety-seven of the 6,153 (17.8%) fellow workers interviewed had symptoms consistent with occupational asthma (new onset asthma or bothered at work by daily or weekly shortness of breath, wheezing or chest tightness) (Table 13).

Three hundred sixty-one workers from 70 companies were listed by employers on the Occupational Safety and Health Administration (OSHA) Injury and Illness log as having asthma or asthma-like symptoms. Eight workers had both daily or weekly breathing symptoms and were listed on the OSHA log. Therefore, a total of 1,450 symptomatic workers were identified during the 430 inspections.

Comparison of Work-Related Asthma in Michigan with Other Geographic Areas

The annual rate of 3.4 cases per 100,000 received in the Michigan surveillance system is similar to the rates reported in other surveillance systems. In England the rates reported vary from 2.0 to 4.3 cases per 100,000 with rates as high as 6.3 per 100,000 reported in some regions (12-14). Similarly in Michigan there is regional variation with rates in some counties as high as 24.1 cases per 100,000 (Table 2). Reported rates in specific occupations in England have ranged as high as 65.0 cases per 100,000 (14). The system in England is voluntary, and is based only on reports received from pulmonary and occupational physicians (15). This differs from Michigan's surveillance system which is mandatory and covers physicians of all specialties. In Michigan 54% of the reports are from occupational and pulmonary physicians, 7% are from allergists and the remaining 38% are from other specialties. Finland has a national mandatory reporting system that is connected with their workers' compensation system; their reported rate is 15.2 cases per 100,000 (16). Isocyanates are typically the most common cause of work-related asthma reported in other surveillance systems (15,17). However, since farmers were included in the workers' compensation system in Finland, cow dander has become the most commonly reported allergen in that count

A more recent report from a study performed at an HMO in Massachusetts estimated the annual rate of work-related asthma at 71.0 cases per 100,000 (19). Possible reasons for this much higher rate reported in the study from Massachusetts include 1) less restrictive case criteria in the HMO study; 2) more intense case-findings in the HMO study; 3) increasing incidence of

work-related asthma between the time of the more recent HMO study and previous studies; and 4) the fact that the annual estimates from the HMO study were extrapolated from cases identified during the 3 month period of July, August, and September.

Cleaning Products

Cleaning agents are widely used in the workplace. In our Fall 1997 PS News Newsletter (Volume 8 No. 4) we evaluated 56 reports of sensitization to cleaning products. Acute high level exposures to cleaning compounds containing ammonia or bleach have caused chemical pneumonitis, pulmonary edema and the long term complication of reactive airways dysfunction syndrome (RADS) (20). Similar lung pathology is caused if bleach and cleansers containing acid are mixed, producing chlorine gas, or if ammonia and bleach are mixed producing chloramine. Twenty-nine of the 56 case reports to SENSOR have RADS involving cleaning compounds.

Disinfectant cleaners may contain a documented occupational allergen such as: benzylkonium chloride, chloramine, chlorhexidine, formaldehyde or glutaraldehyde.

Cases have been reported where cleaners with disinfectants have been used to clean showers, saunas, a meat processing factory, kitchens, operating rooms, dairies and hospital floors. Although the reports typically have involved the individual doing the cleaning, individuals using the area after the cleaning have also developed sensitization and asthma (21,22). Sixteen of the 56 case reports to SENSOR involving cleaning compounds have been for patients who work in a health care

Aliphatic polyamides are commonly found in cleaning compounds. Members of this chemical group that have been associated with work-related asthma are ethylene diamine, diethylene triamine and triethylene tetramine (23). Similarly the ethanolamines, mono and triethanolamine, also found in cleaning solutions, have been associated with work-related asthma

In addition to potential respiratory allergies, cleaning agents may contain substances that cause contact dermatitis. A review of the 1250 different chemicals used in cleaning solutions in Denmark found that 49 (4%) were known causes of contact dermatitis (25). It is important to encourage the patient to obtain information on the specific chemicals to which they were exposed from the product label. A summary of the 56 reports involving patients exposed to cleaning compounds received by SENSOR is shown in Table 14.

Discussion:

In our previous annual reports, we have emphasized the fact that the cases reported in Michigan's surveillance system are likely an underestimation of the true number of cases of work-related asthma in the state. Studies suggest that work exposures are important etiologic agents in a significant percentage (20% or greater) of adults with asthma (3-10,19).

An average of 143 new people each year are reported to the Michigan Department of Consumer and Industry Services (MDCIS) with confirmed work-related asthma. National estimates would indicate that there are a total of 4,600 - 34,500 adults with work-related asthma in the state (3-10). A Michigan study predicts possibly 6,900 - 59,800 adults whose work contributed to the development of their asthma (5). Using capture-recapture analysis we estimate 228-801 adults in Michigan develop work-

related asthma each year(26).

As we found in our previous annual reports on work-related asthma in Michigan, the workers reported are generally young to middle age white men and women, with the greatest number being reported from the Detroit metropolitan area. They work in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. Their predominant causes of work-related asthma remain isocyanates and metal-working fluids.

Asthma symptoms persist despite removal from the precipitating work exposures (Table 10).

Neither personal habits such as cigarette smoking nor individual susceptibility as measured by personal or family history of allergies are predictive of who will develop work-related asthma. Approximately 50% of the asthma patients have no personal or family history of allergies and 80% are not smoking cigarettes at the time their asthma symptoms develop

Although most facilities where the patient developed asthma were not in violation of exposure standards, there were high percentages of symptomatic fellow workers in facilities using occupational allergens. We identified 1097 fellow workers with symptoms compatible with work-related asthma. Three hundred sixty-one individuals were listed on the OSHA log as having work-related asthma. The high percentages of symptomatic individuals are consistent with estimates of the prevalence of work-related asthma in the state. The presence of symptomatic co-workers suggests that some of the occupational health standards are not sufficiently protective to ensure a safe workplace.

The presence of 56 reports involving cleaning agents suggests the need for additional preventive strategies for these commonly used products.

Reevaluations of allowable exposure standards are needed. These reevaluations should consider comprehensive workplace controls which address not only daily average exposures but exposures during spills and leaks and provision of medical surveillance for potentially exposed workers. Medical monitoring is particularly relevant to reducing the burden of work-related causes of asthma. The longer a person with symptoms remains exposed, the more likely their asthma will become a chronic problem (27).

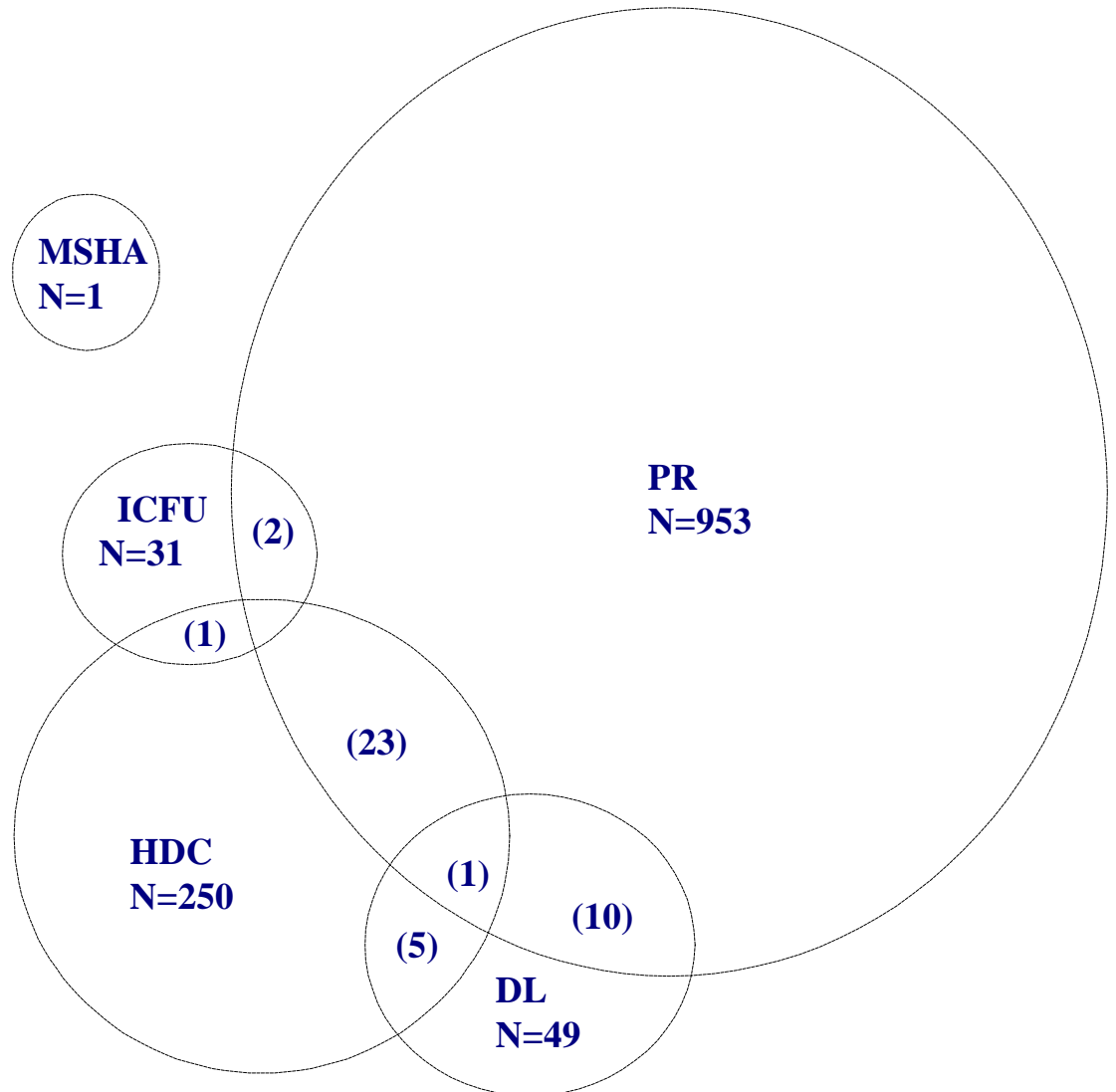
The report of a patient with known or suspected work-related asthma is a sentinel health event that is critical to effective occupational disease surveillance. Case reporting from physicians offers the opportunity for the most timely workplace interventions, compared to receiving reports from hospitals. With continued support and increasing awareness of work-related asthma 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 current permissible levels, suggest the need for the development of new standards, identify new occupational allergens and prevent co-workers from developing

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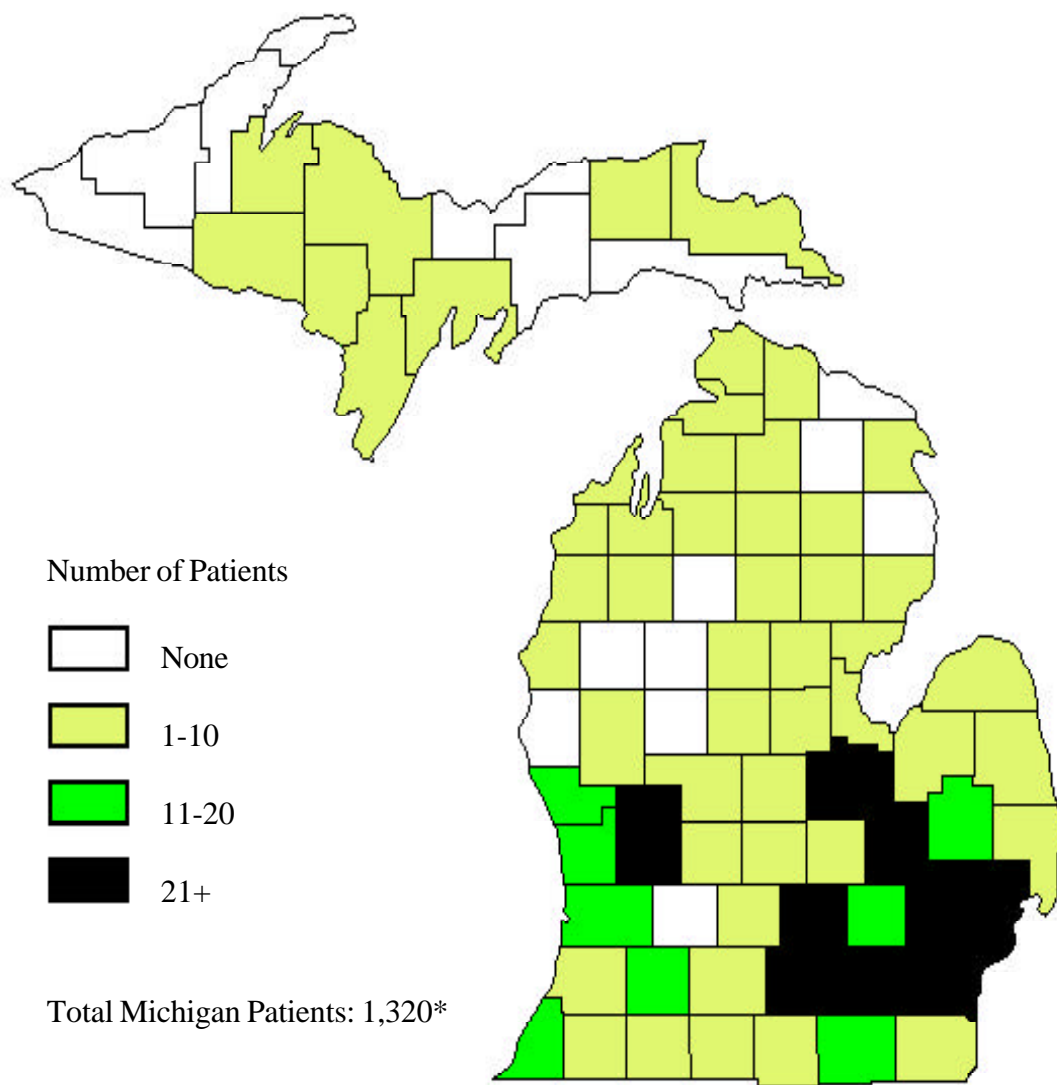
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Figure 1. Overlap of Reporting Sources for Confirmed Work-Related Asthma Patients: 1988-1997*



* Diagram represents 1,241 individuals initially reported from 1988-1997. N's represent the total number for that source. Numbers in parentheses represent the overlap of reporting sources. Reporting Source Codes: HDC=Hospital Discharge Data; PR=Physician Referral; DL=Department of Labor; ICFU=Index Case Follow-Up; MSHA=Mine Safety and Health Administration.

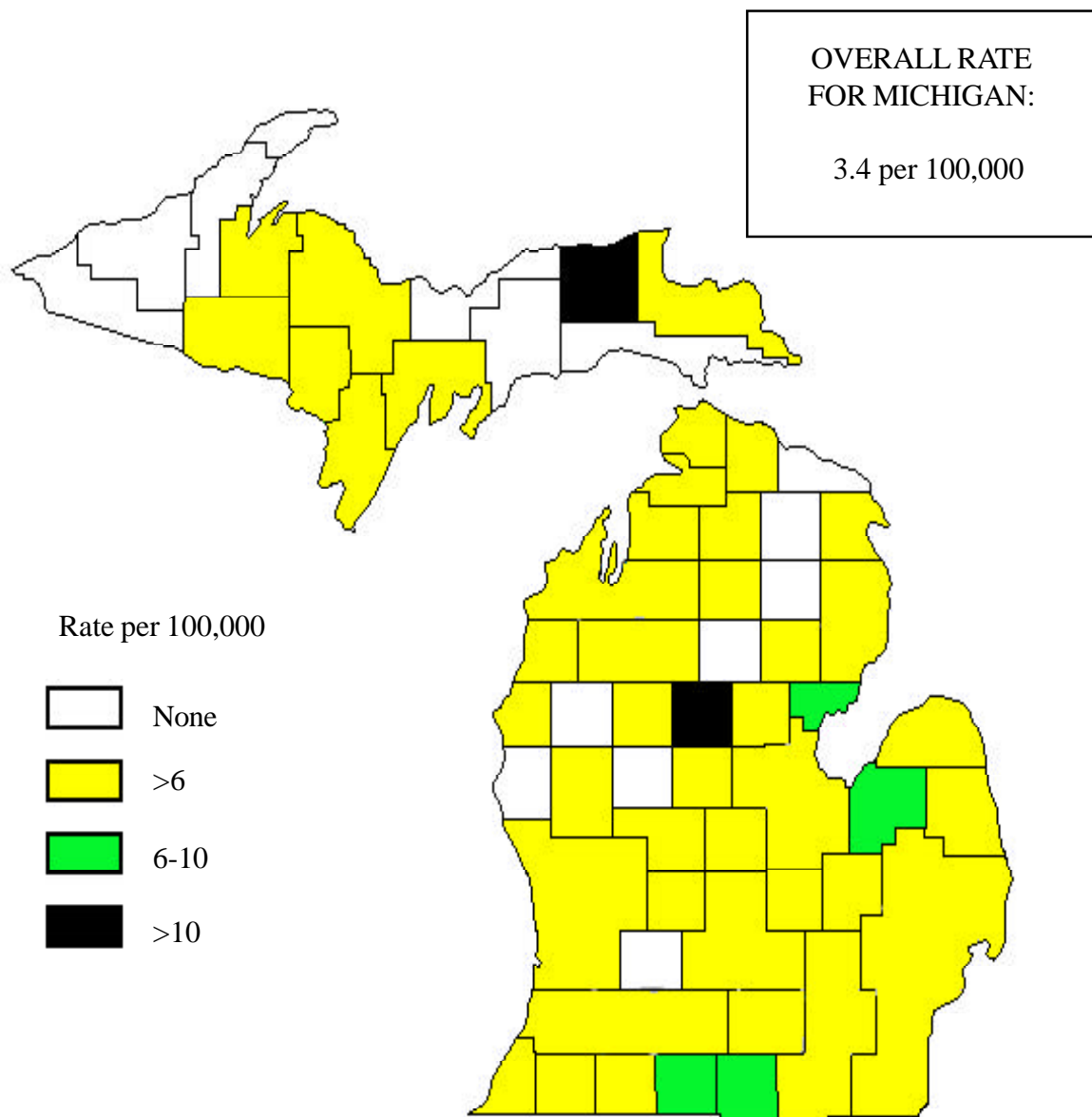
Figure 2. Distribution of Confirmed Work-Related Asthma Patients by County of Exposure: 1988-1998



Oakland and **Wayne** counties had the highest number of work-related asthma patients, with 178 and 378 individuals, respectively.

*County of exposure was unknown for 3 patients. Thirteen patients were exposed to an allergen out-of-state.

Figure 3. Average Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by County of Exposure: 1989-1996*



*Rate per 100,000 among Michigan workers. Source: MESC 1992 Annual Average Labor Statistics for Employment by Place of Work. In 1992, there were a total of 3,928,000 Michigan workers.

Figure 4. Number of Confirmed Cases of Work-Related Asthma by Year and Type

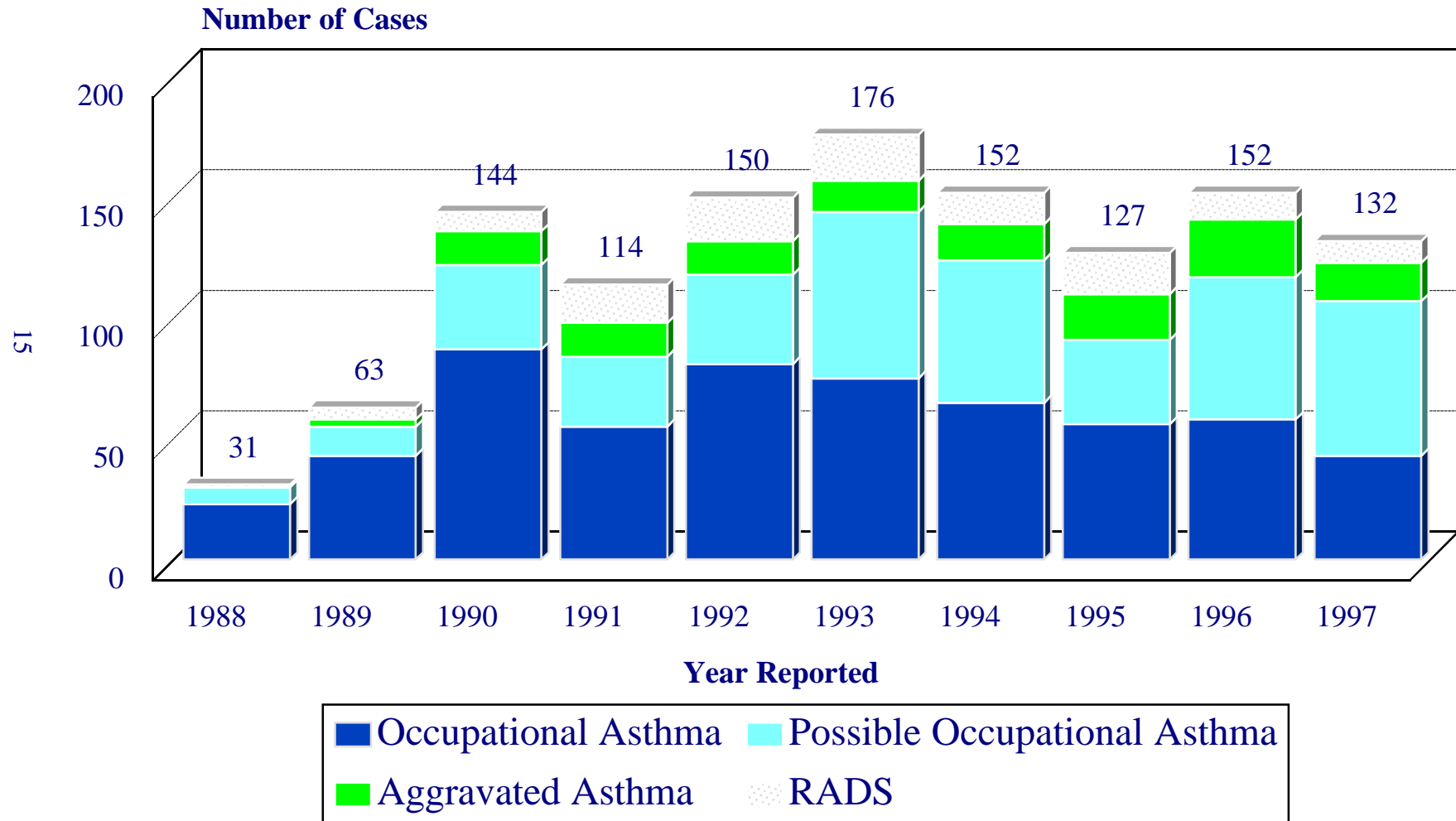
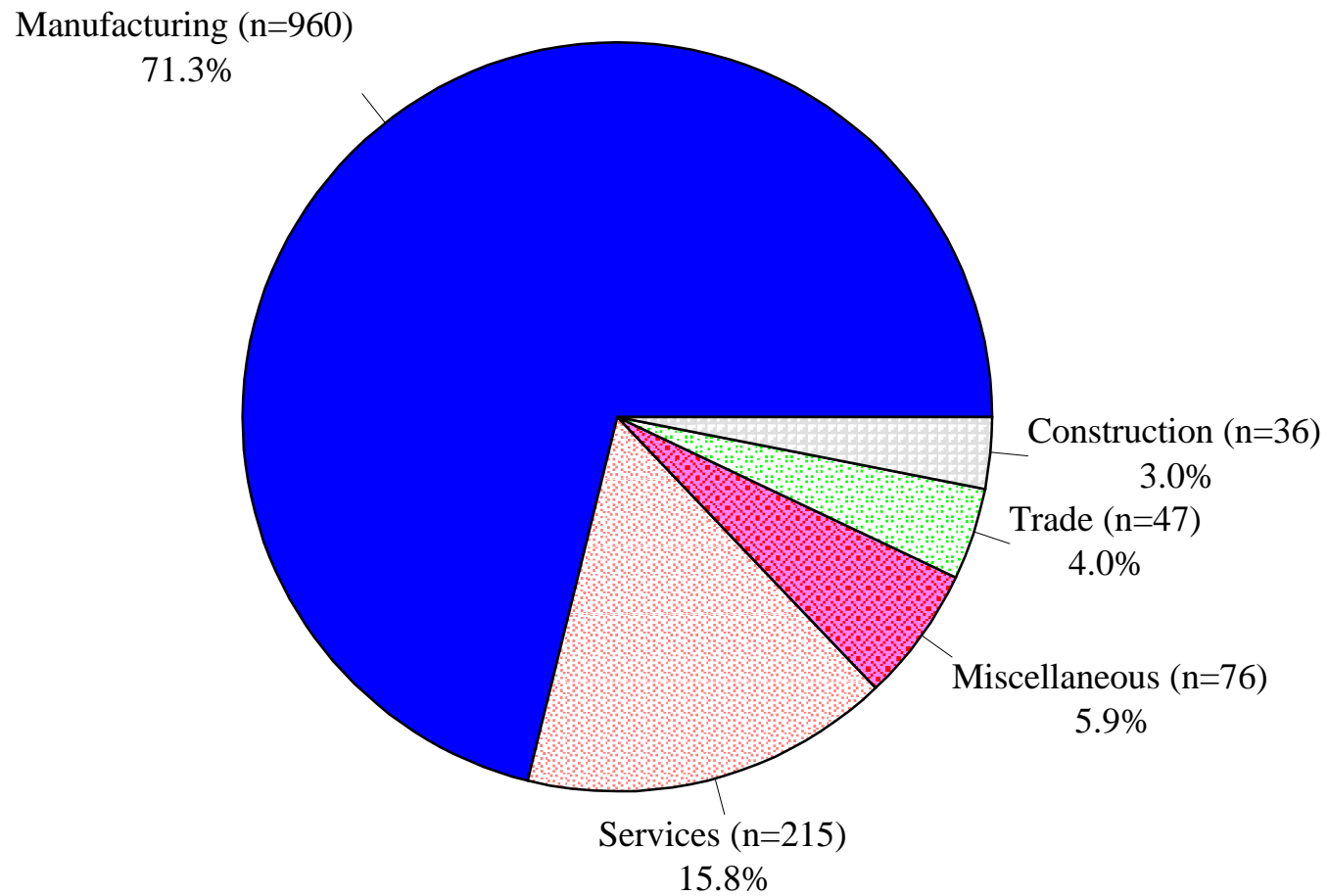


Figure 5. Major Industry Type for Confirmed Work-Related Asthma Patients: 1988-1998*



*Number of patients in parentheses, percent below.

Table 1. Number of Confirmed Cases of Work-Related Asthma by Year and Type

<u>Disease Status*</u>	<u>Year</u>											<u>Total</u>
	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	
OA	23	43	87	55	81	75	65	56	58	43	33	619
POA	7	12	35	29	37	69	59	35	59	64	49	455
AA	0	3	14	14	14	13	15	19	24	16	12	144
RA	1	5	8	16	18	19	13	17	11	9	1	118
Total	31	63	144	114	150	176	152	127	152	132	95	1336

*OA = occupational asthma; POA = possible occupational asthma; AA = aggravated asthma; RA = reactive airway dysfunction syndrome.

**Table 2. Average Annual Incidence Rates of Work-Related Asthma
Among Michigan Workers by County of Exposure: 1989-1996**

<u>County</u>	<u>Number Of Employees*</u>	<u>Avg. Ann. Inc. Rate**</u>	<u>Total # Cases 1989-1996</u>
Alcona and Iosco (0, 2 cases respectively)	10,400	2.4	(2)
Alpena	11,850	3.2	(3)
Antrim	4,700	5.3	(2)
Arenac	4,025	6.2	(2)
Baraga	2,625	4.8	(1)
Berrien	66,600	2.8	(15)
Branch	12,275	7.1	(7)
Cass	9,700	3.9	(3)
Charlevoix	8,725	2.9	(2)
Cheboygan	6,575	5.7	(3)
Chippewa	12,800	2.0	(2)
Clare	6,875	10.9	(6)
Clinton-Eaton-Ingham (3, 7, 34 cases respectively)	215,400	2.6	(44)
Crawford	4,400	5.7	(2)
Delta	13,475	1.9	(2)
Dickinson	12,625	5.9	(6)
Emmet	13,150	1.0	(1)
Genessee	164,600	5.3	(70)
Gladwin	4,225	3.0	(1)
Grand Traverse-Benzie-Kalkaska-Leelanau (6, 2, 3, 2 cases respectively)	49,650	3.3	(13)
Gratiot	12,950	2.9	(3)
Hillsdale	13,575	6.4	(7)
Huron	11,075	3.4	(3)
Ionia	14,850	2.5	(3)
Iron	3,800	3.3	(1)
Isabella	21,575	1.2	(2)
Jackson	54,100	5.1	(22)
Kalamazoo-Calhoun -VanBuren (10,9,3 cases respectively)	193,000	1.4	(22)
Kent-Ottawa-Muskegon -Allegan (30, 11, 13, 6 cases respectively)	453,700	1.7	(60)
Luce	2,075	24.1	(4)
Manistee	6,750	1.9	(1)
Marquette	28,300	2.2	(5)
Mason	9,525	1.3	(1)
Menominee	8,825	1.4	(1)
Montcalm	16,725	5.2	(7)
Newaygo	8,950	2.8	(2)
Ogemaw	5,300	2.4	(1)
Osceola	6,575	1.9	(1)
Otsego	8,475	5.9	(4)
Sanilac	10,800	3.5	(3)
Shiawassee	17,875	1.4	(2)
St. Joseph	21,200	2.4	(4)
Tuscola	12,825	6.8	(7)
Washtenaw-Lenawee-Livingston (65, 11, 18 cases respectively)	242,700	4.8	(94)
Wexford-Missaukee (3, 0 cases respectively)	14,600	2.6	(3)
Saginaw-Bay-Midland (22, 10, 3 cases respectively)	164,900	2.7	(35)
Detroit MSA***	1,852,000	3.9	(579)
Out of State	--	--	(11)
Unknown	--	--	(3)
All Michigan Counties	3,928,000	3.4	(1064)

*Source: MESC 1992 Annual Average Labor Statistics for Employment by Place of Work. Some employee population data is only available at a multi-county level, as indicated (i.e. not available at a single county level). Therefore, some data is presented with grouped counties.

**Rates are based on the average number of cases per year from 1989-1996, per 100,000 Michigan workers.

***MSA=Metropolitan Statistical Area and includes Lapeer (12 cases), Macomb (108 cases), Monroe (7 cases), Oakland (139 cases), St. Clair (6 cases) and Wayne (307 cases) counties.

**Table 3. Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by Major Metropolitan Area
Exposure: 1990-1996**

<u>County</u>	<u>Annual Incidence Rate*</u>						
	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Clinton-Eaton-Ingham (3, 7, and 33 cases respectively)	1.4 (3)	3.8 (8)	5.6 (12)	3.7 (8)	1.8 (4)	2.2 (5)	1.3 (3)
Kent-Ottawa-Muskegon-Allegan (29, 10, 0 and 1 cases, respectively)	2.2 (8)	1.4 (5)	0.7 (3)	1.3 (6)	3.5 (7)	1.2 (6)	0.9 (5)
Saginaw-Bay-Midland (20, 6, and 3 cases, respectively)	2.4 (4)	4.3 (7)	1.8 (3)	1.8 (4)	1.8 (3)	1.7 (3)	2.9 (5)
Detroit MSA**	3.0 (58)	2.7 (50)	4.6 (86)	6.4 (121)	4.4 (85)	3.4 (69)	4.4 (91)
Total (all Michigan)	3.6 (144)	2.9 (114)	3.8 (150)	4.4 (176)	3.7 (152)	2.9 (122)	3.4 (149)

*Rate per 100,000 Michigan workers. Rate, number of cases in parentheses.

Source: MESC Annual Average Labor Statistics for Employment by Place of Work, for each year 1990-1996 separately.

**MSA=Metropolitan Statistical Area. For the years 1990-1995, includes Lapeer (12 cases), Livingston (14 cases), Macomb (104 cases), Monroe (7 cases), Oakland (125 cases), St. Clair (6 cases) and Wayne (292 cases) counties. For 1996, does not include Livingston county because of a change in the counties associated with certain MSA's (including Detroit), beginning in 1996.

Table 4. Primary Industrial Exposure for Confirmed Work-Related Asthma Patients: 1988-1998

<u>Industry (SIC Code)*</u>	<u>Number of Cases (1988-1998)**</u>	<u>Number of Employees***</u>	<u>Ann. Average Inc. Rate****</u> <u>1989-1996</u>
Manufacturing (20-39)			
Automobile (37)	572 (42.8)	272,000	20.8 (452)
Ind. and Comm. mach. and Computer Equipment (35)	55 (4.1)	115,000	5.3 (49)
Fabricated Metal Products (34)	63 (4.7)	114,000	5.5 (50)
Rubber and Misc. Plastic Products (30)	57 (4.3)	52,000	11.1 (46)
Foundries (33)	46 (3.4)	37,000	13.9 (41)
Food and Kindred Products (20)	27 (2.0)	44,000	6.8 (24)
Printing and Publishing (27)	13 (1.0)	45,000	3.3 (12)
Paper and Allied Products (26)	13 (1.0)	21,000	7.1 (12)
Lumber and Wood (24)	10 (0.7)	15,000	8.3 (10)
Electrical Equipment (36)	12 (0.9)	30,000	2.9 (7)
Furniture and Fixtures (25)	4 (0.3)	34,000	1.5 (4)
Apparel Made from Fabric (23)	2 (0.1)	19,000	1.3 (2)
Other Durables (32,38,39)	30 (2.2)	41,000	7.6 (25)
Other Nondurables (22,28,29,31)	56 (4.2)	50,000	11.3 (45)
Wholesale and Retail Trade (50-59)			
Wholesale-Nondurable Goods (51)	10 (0.7)	71,000	1.4 (8)
Food Stores (54)	11 (0.8)	100,000	1.1 (9)
Eating and Drinking Places (58)	7 (0.5)	256,000	0.3 (7)
Wholesale-Durable Goods (50)	10 (0.7)	126,000	0.7 (7)
Automotive Dealers and Gasoline Services (55)	3 (0.2)	75,000	0.5 (3)
General Merchandise Stores (53)	4 (0.3)	118,000	0.3 (3)
Home Furniture and Furnishings (57)	1 (0.1)	27,000	0.5 (1)
Building materials (52)	1 (0.1)	30,000	B --
Services			
Health (80)	111 (8.3)	324,000	2.9 (74)
Education (82)	43 (3.2)	37,000	10.5 (31)
Automotive Repair (75)	8 (0.6)	33,000	2.7 (7)
Business (73)	9 (0.7)	188,000	0.6 (9)
Social Services (83)	7 (0.5)	69,000	1.1 (6)
Engineering, Accounting, etc. (87)	6 (0.4)	80,000	0.8 (5)
Other Services (70,72,76,79,81,86,89)	31 (2.3)	249,000	1.4 (27)
Construction and Mining (10-17)			
Special Trade Construction (17)	23 (1.7)	87,000	3.0 (21)
Other Construction (15-16)	9 (0.7)	42,000	2.7 (9)
Mining (10-14)	4 (0.3)	9,000	5.6 (4)
Miscellaneous Industries			
Government (91-97)	46 (3.4)	639,000	0.8 (39)
Transportation and Utilities (40-49)	22 (1.6)	154,000	1.7 (21)
Finance, Insurance and Real Estate (60-67)	5 (0.4)	191,000	0.3 (4)
Agricultural Production and Services (01,02,07)	3 (0.2)	90,000	0.3 (2)
Unknown	2 (0.1)	--	-- (2)
Total	1336 (99.5)*****	3,928,000	3.4 (1076)

*Standard Industrial Classification.

**Number of cases, percentages are in parentheses.

***Source: MESC 1992 civilian labor force and industrial employment estimates.

****Average annual incidence rate, total number of cases for 1989-1996 are in parentheses. Rates are based on average number of cases from 1989-1996 per 100,000 adult workers in each industrial category.

*****Percent does not add to 100 due to rounding.

**Table 5. Primary Industrial Exposure for Confirmed
Work-Related Asthma Patients: 1990-1996**

<u>Industry (SIC code*)</u>	<u>1990**</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
Manufacturing (20-39)							
Food & Kindred Products (20)	20.0 (9)	6.7 (3)	2.3 (1)	-- (0)	2.3 (1)	4.4 (2)	6.8 (3)
Chemicals & Allied Product & Petroleum Refining (28,29)	18.2 (8)	4.3 (2)	14.0 (7)	12.0 (6)	7.8 (4)	14.3 (7)	*** (3)
Rubber & Misc. Plastic Products (30)	9.3 (5)	19.6 (10)	-- (0)	7.3 (4)	11.3 (7)	15.1 (10)	10.4 (7)
Foundries (33)	9.5 (4)	23.7 (9)	8.1 (3)	19.4 (7)	18.9 (7)	5.4 (2)	18.9 (7)
Fabricated Metal Products (34)	6.6 (8)	4.4 (5)	2.6 (3)	3.4 (4)	5.7 (7)	3.1 (4)	12.5 (16)
Industrial & Commercial Machinery & Computer Equipment (35)	1.7 (2)	6.1 (7)	8.5 (10)	6.6 (8)	3.0 (4)	3.0 (4)	
Automobile (37)	19.0 (56)	15.6 (44)	28.7 (82)	26.5 (74)	25.0 (71)	17.3 (51)	21.1 (59)
Other Durables (38,39)	19.2 (5)	8.0 (2)	4.9 (2)	9.8 (4)	-- (0)	-- (0)	6.7 (3)
Miscellaneous Industries							
Special Trade Construction (17)	1.1 (1)	2.3 (2)	4.6 (4)	6.7 (6)	3.2 (3)	0.9 (1)	1.7 (2)
Transportation & Utilities (40-49)	0.6 (1)	1.3 (2)	1.9 (3)	4.5 (7)	2.5 (4)	1.2 (2)	B (0)
Health (80)	1.6 (5)	1.9 (6)	3.4 (11)	3.6 (12)	3.8 (13)	3.7 (13)	3.3 (12)
Education (82)	5.4 (2)	5.3 (2)	8.1 (3)	21.1 (8)	7.7 (3)	10.2 (4)	18.6 (8)
Government (91-97)	8.1 (5)	6.6 (4)	7.9 (5)	14.3 (9)	6.3 (4)	1.1 (7)	0.8 (5)
Total (all industries)	3.4 (144)	2.8 (114)	3.5 (150)	4.0 (176)	3.4 (152)	3.0 (127)	3.3 (152)

*Standard Industrial Classification.

**Annual Incidence rate, number of cases for that year are in parentheses.

Rates are based on the number of cases per 100,000 adult workers in Michigan

for each year separately. Source: MESC Annual Average civilian labor force and industrial employment estimates.

***Denominator not available in 1996.

Table 6. Occupational Allergens Identified for 1336 Confirmed Work-Related Asthma Patients: 1988-1998

<u>Allergen</u>	<u>Number</u>	<u>Percent</u>
Isocyanates	255	19.1
Metal-Working Fluids	163	12.2
Unknown (Mfg.)	92	6.9
Unknown (Office)	87	6.5
Exhaust, Smoke, Fumes	73	5.5
Welding Fumes	66	4.9
Cleaning Solutions	58	4.3
Solvent	41	3.1
Epoxy	35	2.6
Formaldehyde	34	2.5
Rubber	32	2.4
Acrylates	30	2.2
Acids	25	1.9
Chlorine	24	1.8
Paint Fumes	22	1.6
Styrene	19	1.4
Cobalt	19	1.4
Wood Dust	14	1.0
Plastic Fumes	14	1.0
Flour	12	0.9
Ammonia	12	0.9
Chromium	11	0.8
Herbicide, Pesticide	11	0.8
Printing Inks	10	0.7
Amines	9	0.7
Caustics	8	0.6
Grain Dust	7	0.5
Pickling Ingredients	6	0.4
Animals	6	0.4
Fiberglass	5	0.4
Meat Wrappers' Asthma	5	0.4
Rose Hips	4	0.3
Sulfonate	4	0.3
Sulfur Dioxide	4	0.3
1,1,1 Trichloroethane	4	0.3
Cement Dust	4	0.3
Colophony	3	0.2
Cosmetology Chemicals	3	0.2
Nitrogen	3	0.2
Photo Developing Fluids	3	0.2
Nickel	3	0.2
Phthalic Anhydride	3	0.2
Glutaraldehyde	3	0.2
Cadmium Solder	2	0.1
Enzymes	2	0.1
Other*	86	6.4
Total	1336	99.3**

*Includes: x-ray developing fluids, chemicals used in the construction industry, freon, sulfite, gas and oil refinery exposures, maleic anhydride, solder fumes, vinyl acetate, ozone, zinc, textile lint, 1,3, dichloro-2-propanol, pepper gas, exercise, weeds, soda ash, asbestos, limone, coal dust, ethylene oxide, trichloroethylene, iodine, polyvinyl butyrate, lime dust, polyester, MEK, nylon-polyhexamethylene adipamide, potassium aluminum fluoride, ammonium hydroxide, methanol, naphtha, drywall dust, paper dust, zinc oxide, methylene chloride, ethylene glycol monobutyl ether, sewage, tar fumes, monoammonium phosphate, potassium hydroxide, ethyl alcohol, heptane, stress, sodium hydroxide, platinum, phosgene, cyanide, heat, polyethylene, perchloroethylene, hydraulic oil, blood, 1,3 dichloro 5 5-dimethyl hydrantoin, ninhydrin, cigarette smoke, azodicarbamide, and lactase.

**Percentages do not add to 100 due to rounding.

Table 7. Cigarette Smoking Status of Confirmed Work-Related Asthma Patients: 1988-1998

<u>Smoking Status</u>	<u>Disease Status</u>				
	<u>ALL</u> *	<u>OA</u> **	<u>POA</u>	<u>AA</u>	<u>RA</u>
Current Smoker	260 (19.9)	138 (22.7)	68 (15.2)	29 (21.6)	25 (21.6)
Ex-Smoker	554 (42.5)	251 (41.3)	201 (45.1)	46 (34.3)	56 (48.3)
Non-Smoker	490 (37.6)	219 (36.0)	177 (39.7)	59 (44.0)	35 (30.2)
Total	1304	608	446	134	116

*Total number of cases: 1304. Smoking status was missing on 32 individuals.

Number of patients, percentages are in parentheses.

**OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma;

RA=reactive airway dysfunction syndrome.

Table 8. Family History of Allergies Among Confirmed Work-Related Asthma Patients: 1988-1998

Family History of Allergies	Disease Status				
	<u>ALL</u>*	<u>OA</u>**	<u>POA</u>	<u>AA</u>	<u>RA</u>
YES	495 (41.2)	214 (37.8)	169 (41.0)	67 (58.8)	45 (41.3)
NO	706 (58.8)	352 (62.2)	243 (59.0)	47 (41.2)	64 (58.7)
Total	1201	566	412	114	109

*Total number of cases: 1201. Missing data on 135 patients. Number of patients, percentages are in parentheses.

**OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RA=reactive airway dysfunction syndrome.

**Table 9. Personal History of Allergies or Asthma
Among Confirmed Work-Related Asthma
Patients: 1988-1998**

Personal History	Disease Status				
	<u>ALL</u>*	<u>OA</u>**	<u>POA</u>	<u>AA</u>	<u>RA</u>
YES	611 (45.7)	250 (40.4)	191 (42.0)	131 (91.0)	39 (33.1)
NO	725 (54.3)	369 (59.6)	264 (58.0)	13 (9.0)	79 (66.9)
Total	1336	619	455	144	118

*Number of patients, percentages are in parentheses.

**OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RA=reactive airway dysfunction syndrome.

**Table 10. Persistence of Symptoms and Medication
Use in Confirmed Work-Related Asthma Patients: 1988-1998**

<u>Exposure Status</u>	<u>Total*</u>	<u>Symptoms</u>		<u>Asthma Medications</u>	
		<u>Yes</u>	<u>Less</u>	<u>Yes</u>	<u>Less</u>
Still Exposed	390	373 (95.6)	138 (35.4)	329 (84.4)	86 (22.1)
No Longer Exposed	860	710 (82.6)	435 (50.6)	646 (75.1)	268 (31.2)
Total	1250	1083	573	975	354

*Total number of cases: 1250. Information missing on 86 individuals. Number of patients, percentages are in parentheses.

**Table 11. Status of Facilities Where 1336 Patients with
Confirmed Work-Related Asthma were
Exposed to Allergens: 1988-1998**

<u>Inspection Status</u>	<u>Number of Patients Represented</u>	<u>Number</u>	<u>Percent</u>
Inspections	757	430*	46.0
No Follow-up Planned	479	410	43.9
Scheduled for Inspection	6	6	0.6
Closed	28	26	2.8
No Longer Use Occupational Allergen	18	17**	1.8
Sent Company an Indoor Air Letter	13	11	1.2
Sent Company a Letter to Check Exposures	35	34	3.6
Total	1336	934***	99.9****

*430 inspections were conducted in 389 different facilities.

**Five companies that no longer use the allergen were previously inspected.

***Represents 888 different facilities.

****Percent does not add to 100 due to rounding.

Table 12. Results of 430 Industrial Hygiene Inspections in 389 Facilities Where Patients with Confirmed Work-Related Asthma were Exposed to Allergens: 1988-1998

<u>Inspection Results</u>	<u>Number</u>	<u>Percent</u>
Air Sampling - NIOSH Standard		
Above NIOSH Standard	35	8.1
Below NIOSH Standard	244	56.7
No NIOSH Standard	6	1.4
Unknown (no report yet)	16	3.7
Did Not Sample for an Allergen	8	1.9
<u>Did Not Sample</u>	<u>121</u>	<u>28.1</u>
Total	430	99.9*
Air Sampling - MIOSHA Standard		
Above MIOSHA Standard	19	4.4
Below MIOSHA Standard	265	61.6
No MIOSHA Standard	2	0.5
Unknown (no report yet)	16	3.7
Did Not Sample for an Allergen	7	1.6
<u>Did Not Sample</u>	<u>121</u>	<u>28.1</u>
Total	430	99.9*

*Percent does not add to 100 due to rounding.

**Table 13. Symptoms Consistent with Work-Related Asthma
Among Fellow Workers of the 1336 Confirmed
Work-Related Asthma Patients**

<u>Symptoms*</u>	Disease Status of Index Patient				
	<u>ALL**</u>	<u>OA</u>	<u>POA</u>	<u>AA</u>	<u>RA</u>
Daily or Weekly SOB, Wheezing or Chest Tightness	1097 (17.8)	857 (18.3)	202 (16.6)	4 (16.0)	34 (15.3)
<u>OSHA Log***</u>	361 (16.2)	298 (20.0)	53 (9.6)	2 (12.5)	8 (5.6)
Total	1458****	1155****	255	6	42

*Denominator for calculating percentages was the number of workers interviewed. SOB=shortness of breath.

**Number of individuals with symptoms, percentages are in parentheses. OA=occupational asthma; POA=possible occupational asthma; AA=aggravated asthma; RA=reactive airways dysfunction syndrome.

***Numerator for calculating percentages was the number of companies with an employee other than the index patient on the OSHA log. Denominator for calculating percentages was the number of companies inspected.

****Eight individuals were identified both on the questionnaire and the OSHA log.

Table 14. Reports Received of Patients with Work-Related Asthma from Exposure to Cleaning Solutions

<u>Location</u>	<u>Total Patients</u>	<u>Occupations (#pts.)</u>	<u>Suspected Substances</u>	<u>Asthma Type*</u>
Health Care	16	Dietary Aide; Housekeeper (6); Lab Technician (2); Laundry Aide; Nurse; Nurse Assistant Paramedic; Patient Caretaker; Secretary; Social Worker	Bleach Carpet Cleaner Carrascent Odor Eliminator® Citrus Oil Cleaning Products Floor Cleaner Hydrochloric Acid Lime-A-Way® Mixed Acid & Bleach Mixed Bleach & Ammonia Mixed Cleansing Agents Mixed Lime-A-Way®, Comet® and Bleach Top Gun® The Works®	R S S S,R,S S S S R R R,S R A R
Restaurant	9	Bus Boy; Dishwasher (3); Cashier; Cook (2); Janitor; Server	Mixed Bleach & Acid Mixed Bleach & Ammonia Mixed Bleach & Chlorine Mixed Bleach, Delimer and Lime-A-Way® Mixed Lime-A-Way® & Cleaner Muriatic Acid	R,R R R R,R,R A A
Hotel	5	Housekeeper (5)	All Purpose Cleaner Bleach Mixed Bleach & Ammonia Tilex® & Lime Remover Window & Bathroom Cleaner, and Bleach	A R R A S
Retail	5	Cake Decorator; Cashier; Clerk; Janitor; Manager	Ammonia, Carburetor Cleaner Cleaner Drain Cleaner Muriatic Acid Zep Pride®	R R R R S
School	5	Cafeteria Aide; Custodian (3); Teacher	Bleach & Solvents Cleaning Product Lime-Off® Micro-Quat®, Oven Cleaner, & Lime-A-Way® Mixed Bleach & Cleaner	S S R S R
Manufacturing Facilities	4	Janitor (4)	Cleaning Solution Floor Cleaner Mixed Bleach & Ceramic Cleaner Triple O®	S S R A
Offices	4	Bank Loan Processor; Telephone Operator; Cook @ Police Dept; Janitor	Cleaning Compounds Cleaning Solution for Vomit, Carpet Cleaner Mixed Bleach & Soap Pine-Sol®	S R R S
Jail	2	Laundry Worker; Teach Custodial Maintenance	Ammonia, Bleach Disinfectants Rugbee Foam Shampoo®	S S
Miscellaneous	6	Camp Counselor; City Hockey Rink Maintenance; Country Club Janitor; Janitor @ Military Base; Health Club Attendant; Truck Driver	Bug Spray, Carpet Fresh® Mixed Soap & Acid Plastic Cleaner Sulfuric Acid Tilex® TimeSaver®	R R S R R S

*A=Aggravation of Pre-Existing Asthma; R = RADS; S = Possible Sensitization