

# 1997 Annual Report on Work-Related Asthma in Michigan

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

February 25, 1998

## Summary:

This is the seventh annual report on work-related asthma in Michigan. An average of 132 new people each year are reported to the Michigan Department of Consumer and Industry Services (MDCIS) \* with asthma caused by work. The reports received by the Michigan Department of Consumer and Industry Services represent 0.2 - 2.9% of the number of estimated people in Michigan with work-related asthma. Inspections at the workplaces where these individuals worked 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 isocyanates are needed. Federal OSHA is currently considering lowering the exposure standard for metal working fluids. Recent analysis of our Michigan data indicates increased symptoms among workers exposed to the newer synthetic metal working fluids in comparison to the mineral oil based fluids (1).

\*Effective May 14, 1996, the Michigan Department of Public Health Division of Occupational Health became part of the Bureau of Safety and Regulation within the newly created Department of Consumer and Industry Services. This division and its authority to collect occupational disease reports were transferred through Executive orders 1996-1 and 1996-2.

## 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 State of Michigan, initially the Michigan Department of Public Health now the Michigan Department of Consumer and Industry Services (MDCIS) 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 workrelated 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.

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 Airway 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).

## **Results:**

### *Reports*

Table I shows that 1179 people were confirmed with work-related asthma between 1988-1997. 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 thirty-two 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; 139 in 1996; and 83 in 1997. Figure 1 shows the overlap of the 1096 patients by reporting sources for 1988-1996.

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 1996 and 1997, and patient interviews are still needed for 4 reports of patients from hospitals and 2 reports of patients from physicians in 1996; and, 45 reports of patients from physicians in 1997.

### *Gender*

Six hundred eleven (51.8%) of the persons with work-related asthma are men and 568 (48.2%) are women.

### *Race*

Nine hundred four (76.7 %) of the persons with work-related asthma are white, 222 (18.8 %) are African American, 32 (2.7%) are Hispanic, 6 (0.5%) are Alaskan or American Indian, 4 (0.3 %) are Asian, and 11 (0.9 %) are other.

### *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 (342 cases, 29.3%), Oakland (147 cases, 12.6%), and Macomb (120 cases, 10.3 %). 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, Clare (12.9 per 100,000) and Benzie (9.1 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, 1991, 1992, 1993, 1994, and 1995 separately.

### *Type of Industry*

Table 4 shows the types of Michigan industries where the exposures to the occupational allergens occurred from 1988 to 1997. Figure 5 shows the distribution of major industry types for all cases identified from 1988-1997. The predominant industries for the total number of cases identified between 1988 and 1997 were in the manufacturing sector: automobile (42.1 %), industrial and commercial machinery and computer equipment (4.5 %), chemical (4.1 %), foundries (3.7 %), fabricated metal products (4.8 %), 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 (7.2 %).

The incidence rate of work-related asthma by industry type ranges from 0.3 cases per 100,000 in agriculture, to a high of 19.9 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: the manufacture of chemicals and petroleum products with 11.8 cases per 100,000 workers; foundries with 12.8 cases per 100,000 workers; the manufacture of rubber products with 10.9 cases per 100,000 workers and the manufacture of other nondurables with 10.7 cases per 100,000 workers.

Table 5 shows the annual incidence rates for the 1990, 1991, 1992, 1993, 1994, and 1995 work-related cases within those industries which had 20 or more reports.

Overall, by broad industrial classification, there were 10.6 cases per 100,000 workers in the manufacturing

industry; 3.1 cases per 100,000 workers in the construction and mining industry; and 2.0 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 (19.4%), metal working fluids (12.4%), vehicle exhaust (5.4%), welding fumes (5.2%), and solvents (3.2%). The agent has not yet been identified for 146 patients (12.4%). The exposures to unknown agents occurred 76 times in the manufacturing sector and 70 times in an office setting.

### *Medical Results*

Table 7 shows patients' cigarette smoking status. Twenty percent 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 twenty-five (41.8%) of the 538 patients with a personal history of allergies or asthma previously had asthma.

Nine hundred fifty-eight of the patients identified with work-related asthma had persistence of their asthma symptoms (Table 10). This was true for 330 of 346 (95.4%) of those still exposed as well as 628 of 755 (83.2%) no longer exposed to the substance causing their asthma. Among those no longer exposed, 50.9% stated their symptoms were less severe compared to 35.3% among those still exposed who reported their symptoms were less severe. Similarly, 84.1% of those still exposed were continuing to take asthma medications while 74.4% of those no longer exposed were still taking asthma medications. Among those no longer exposed, 30.1% stated they were taking less medications while only 22.5% of those still exposed were taking less medications (Table 10).

Five hundred twenty-eight of 1084 (48.7%) patients with known workers' compensation status had applied for workers' compensation. Cases were pending for 256 (48.5%) of those who applied, while 189 (35.8%) had received awards and 83 (15.7%) had been denied.

### *Industrial Hygiene*

The 1179 people with work-related asthma worked at 746 different facilities. Inspections were performed at 372 (45.9%) of these facilities. Twenty-one inspections were completed since last year's report. Inspections are scheduled at 74 (9.1%) facilities (Table 11).

Air sampling for allergens was conducted during 249 of the inspections. Thirty-three of the 249 (13.2%) facilities were above the National Institute for Occupational Safety and Health recommended exposure limit (REL). Nineteen of the 249 (7.6%) were above the enforceable Michigan Occupational Health and Safety Administration (MIOSHA) permissible exposure limit (PEL) (Table 12).

Interviews of fellow workers were performed at 270 of the 372 inspections. Workers had daily or weekly breathing symptoms in 197 of the 270 (73.0%) companies. The average percentage of workers with symptoms in these 197 companies was 22.0%, ranging from 2% to 100%. Interviews conducted in 73 companies found no co-workers with symptoms. Nine hundred ninety-three of the 5,377 (18.5%) 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).

Two hundred thirty-seven workers from 59 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 1,222 symptomatic workers were identified during the 372 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 12.9 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 a voluntary one which 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 common reported allergen in that country (18).

## 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.

An average of 132 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 1,246-6,337 adults with work-related asthma (19).

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 55 % 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 (Tables 7-9).

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 993 fellow workers with symptoms compatible with work-related asthma. Two hundred thirty-seven 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 protective enough to provide a safe workplace.

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 (20).

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 workrelated 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 disease.

## References

1. Rosenman KD, Reilly MJ, and Kalinowski DJ. *Work-Related Asthma and Respiratory Symptoms Among Workers Exposed to Metal-Working Fluids*. American Journal of Industrial Medicine 1997; 32:325-331.
2. Guidelines for the Diagnosis and Management of Asthma. NHLBI, National Asthma Education Program Expert Panel Report. Journal of Allergy and Clinical Immunology 1991; 88: 425-534.
3. Kobayashi S. *Different Aspects of Occupational Asthma in Japan*. In: Frazier CA, ed 1980 Occupational Asthma. New York: Van Nostrand Reinhold, 1980; 229-244.
4. Blanc P. *Occupational Asthma in a National Disability Survey*. Chest 1987; 92:613-617.
5. Salvaggio J ed. *Occupational and Environmental Respiratory Disease in NIAID Task Force Report: Asthma and Other Allergic Disease*. Washington D.C.: U. S. Department of Health Education and Welfare, May 1979 (NIH Publication no. 79-387).
6. Timmer S, and Rosenman KD. *Occurrence of Occupational Asthma*. Chest 1993; 104:816-820.
7. Reijula K, Haahtela T, Klaukka T and Rantanen J. *Incidence of Occupational Asthma and Persistent Asthma in Young Adults has Increased in Finland*. Chest 1996; 110:58-61.
8. Ng TP, Hong CY, Goh LG, Wang ML, Koh KTC and Ling SL. *Risks of Asthma Associated with Occupations in a Community-Based Case-Control Study*. American Journal of Industrial Medicine 1994; 25:709-718.
9. Kogevinas M, Anto JM, Soriano JB, Tobias A and Burney P. *The Risk of Asthma Attributable to Occupational exposures. A Population-Based Study in Spain*. American Journal Respiratory and Critical Care Medicine 1996; 154:137-143.
10. Blanc PD, Cisternas M, Sarith S and Yelin EH. *Asthma, Employment Status, and Disability Among Adults Treated by Pulmonary and Allergy Specialists*. Chest 1996; 109:56S-57S.
11. Brooks SM, Weiss MA, and Bernstein IL. *Reactive Airways Dysfunction Syndrome (RADS) \*: Persistent Asthma Syndrome After High Level Irritant Exposures*. Chest 1985; 83:376-384.
12. Gannon PFG, Burge PS. *A Preliminary Report of a Surveillance Scheme of Occupational Asthma in the West Midlands*. British Journal Industrial Medicine. 199 1; 48:579-582.
13. Meredith SK, Taylor VM, McDonald JC. *Occupational Respiratory Disease in the United Kingdom 1989: A Report to the British Thoracic Society and the Society of Occupational Medicine by the Project Group*. British Journal Industrial Medicine. 1991; 48:292-298.
14. Meredith S. *Reported Incidence of Occupational Asthma in the United Kingdom, 1989-1990*. Journal Epidemiol Community Health. 1993; 47:459-463.



15. Gannon PFG, Burge PS. *The SHIELD Scheme in the West Midlands Regions, United Kingdom*. British Journal Industrial Medicine. 1993; 50:791-796.
16. Keskinen H. *Epidemiology of Occupational Lung Disease: Asthma and Allergic Alveolitis*. In: Keff JW, Ganderton MA, eds. *Proceedings of XI International Congress of Allergy and Clinical Immunology*, London, 1982. London: MacMillan; 1983:403-407.
17. Lee HS, Phoon WH, Wang YT, et al. *Occupational Asthma in Singapore. A Review of Cases From 1983 to 1990*. Singapore Medical Journal. 1991; 32:398-402.
18. Reijula K, Patterson R. *Occupational Allergies in Finland in 1981-1991*. Allergy Proc.1994; 15:163-168.
19. Hook EB, Regal RR. *Capture-Recapture Methods in Epidemiology: Methods and Limitations*. Epidemiologic Reviews 1995; 17:243-264.
20. Chan-Yeung M and Malo JL. *Occupational Asthma*. New England Journal of Medicine 1995; 333:107-112.

*This report was funded by the National Institute for Occupational Safety and Health, under cooperative agreement #U60-CCU502998-11.*

Figure 1. Overlap of Reporting Sources for Confirmed Work-Related Asthma Patients: 1988-1996\*

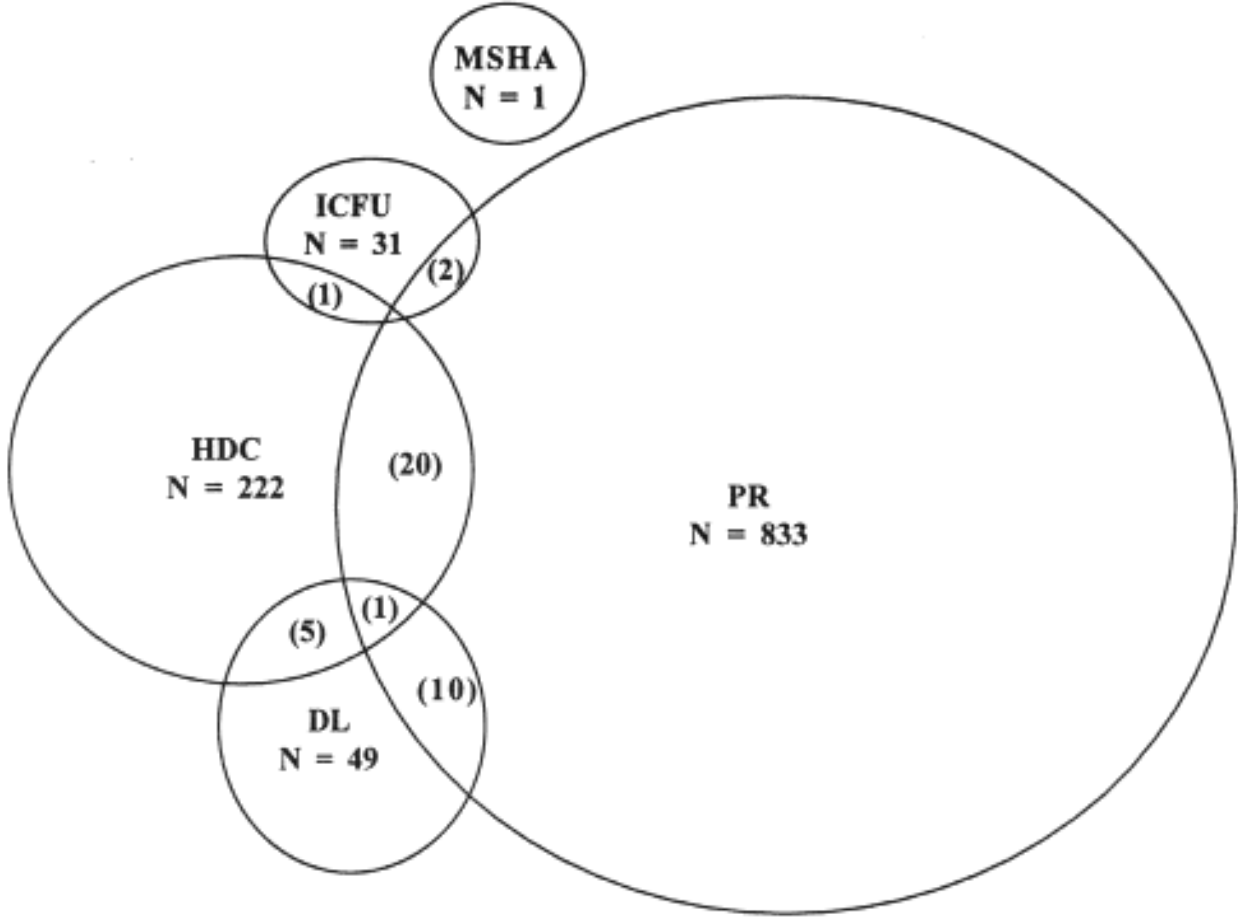
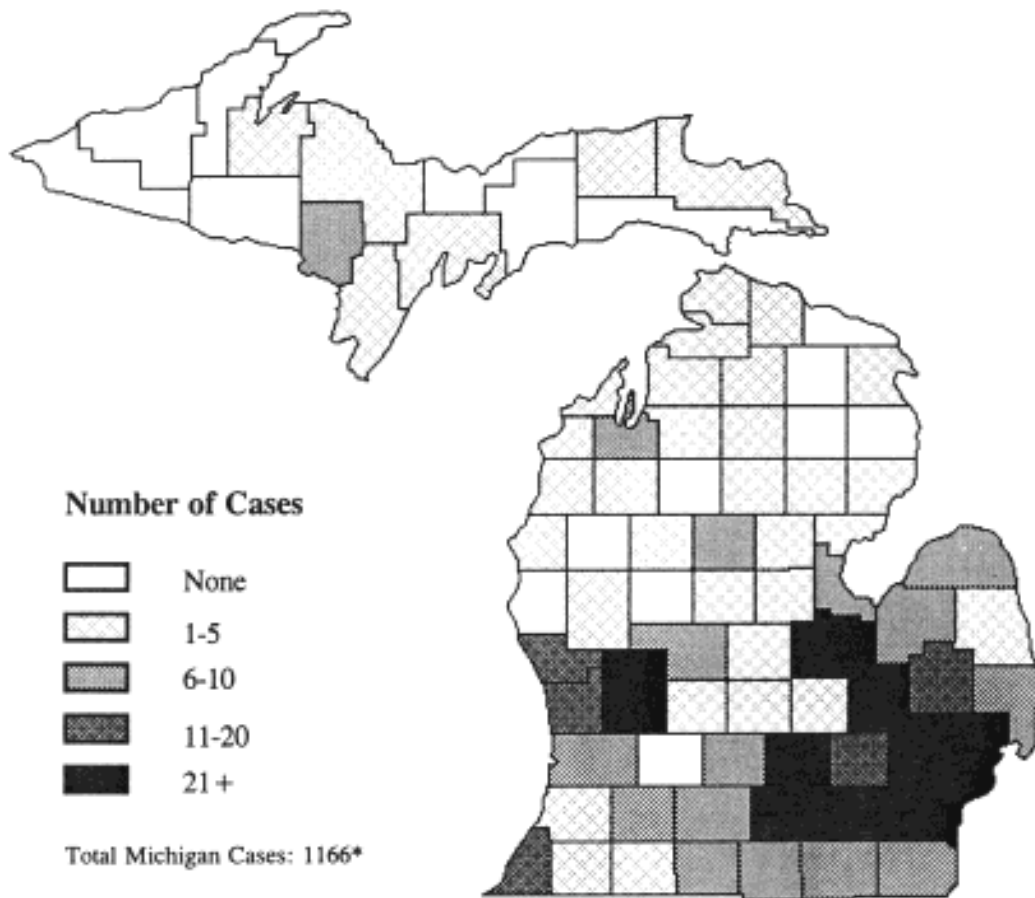


Diagram represents 1,096 patients initially reported from 1988 to 1996. N's represent the total number for that source. Numbers in parentheses represent the overlap of reporting sources. Reporting Source Codes: PR = Physician Referral; HDC = Hospital Discharge Data; ICFU = Index Case Follow Up; DL = Department of Labor claims.

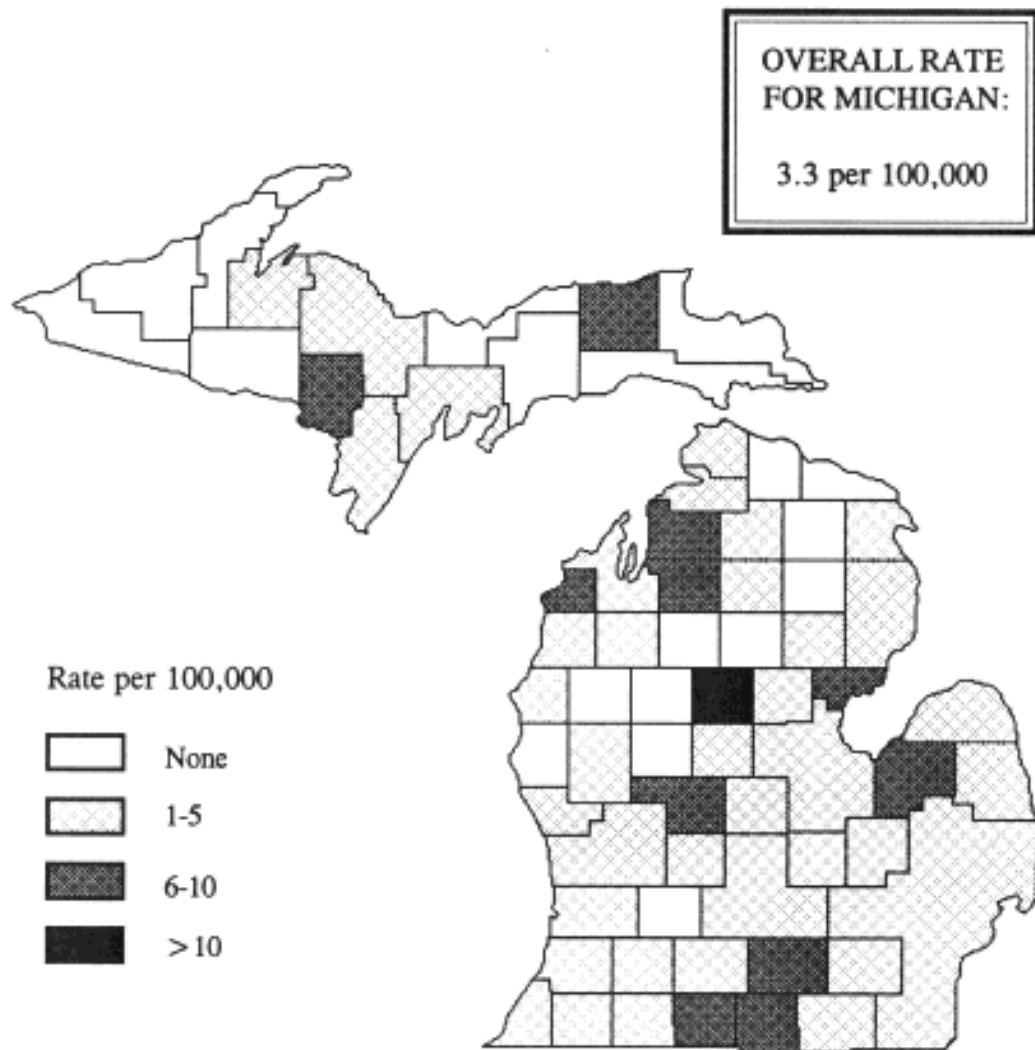
Figure 2. Distribution of Confirmed Work-Related Asthma Patients by County of Exposure: 1988-1997



Oakland and Wayne counties had the highest number of cases, with 147 and 342, respectively.

County of exposure was unknown for two patients. Eleven 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: 1988-1995\*



\*Rate per 100,000 among Michigan workers. Source: MESC 1991 Annual Average Labor Statistics for Employment by Place of Work. In 1991, there were a total of 3,891,200 Michigan workers.

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

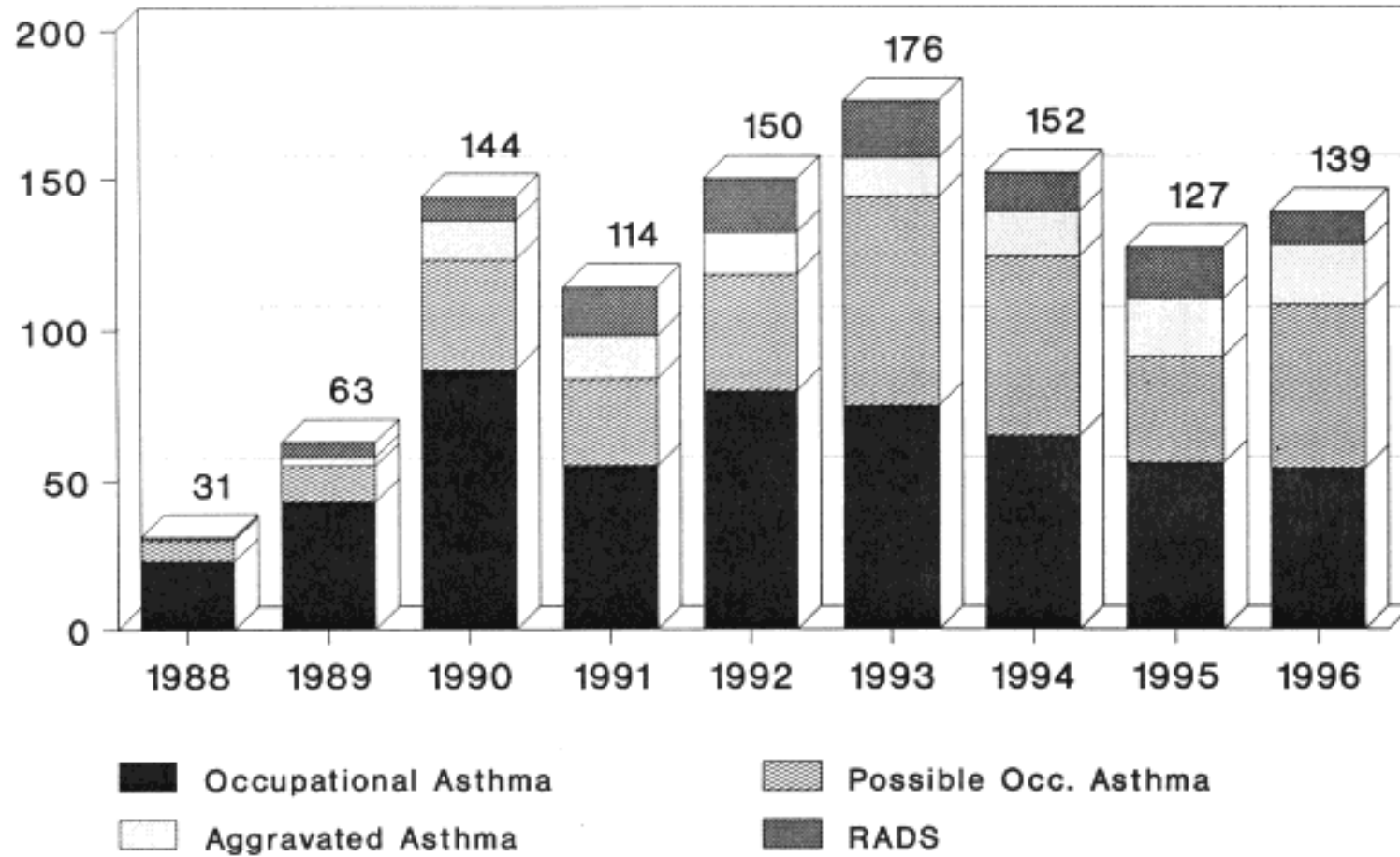
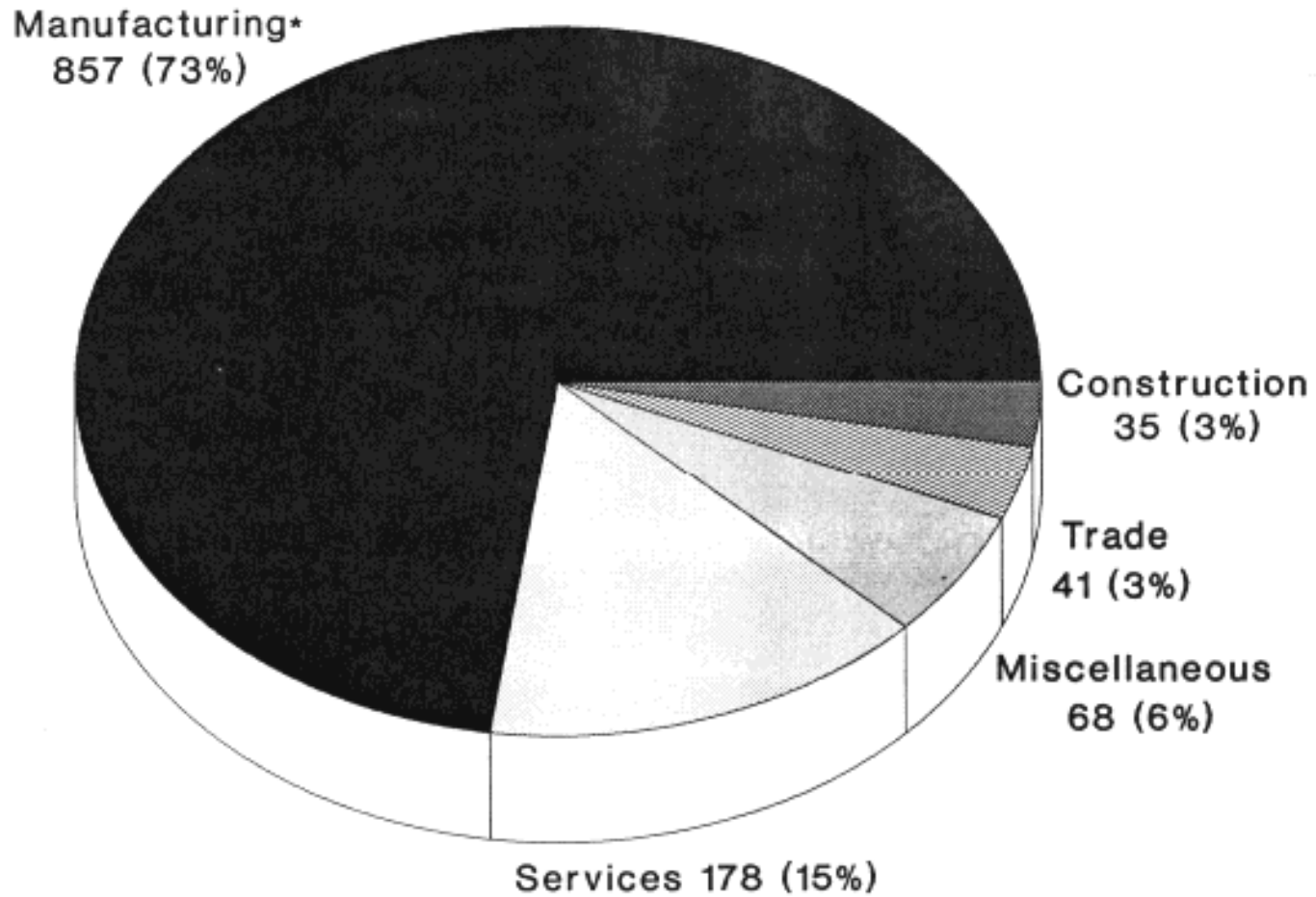


Figure 5. Major Industry Type for Confirmed Work-Related Asthma Patients: 1988-1997



\* Number of patients, percent in parentheses.

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

<u>Disease Status</u>	<u>Year</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>
OA	23	43	87	55	80	75	65	56	54	29
	567									
POA	7	12	36	29	38	69	59	35	54	40
	379									
AA	0	3	13	14	14	13	15	19	20	9
	120									
RA	1	5	8	16	18	19	13	17	11	5
	113									
Total	31	63	144	114	150	176	152	127	139	83
	1179									

\*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: 1989-1995**

<u>County</u>	<u>Number Of Employees</u>	<u>Ave. Ann. Inc. Rate**</u>	<u>Total # Cases 1989-1995</u>
Alcona and Iosco (0, 2 cases respectively)	10,275	2.8	(2)
Allegan	29,375	2.4	(5)
Alpena	11,800	3.6	(3)
Antrim	4,650	6.1	(2)
Arenac	4,000	7.1	(2)
Baraga	2,675	5.3	(1)
Benzie	3,150	9.1	(2)
Berrien	66,000	3.2	(15)
Branch	12,575	6.8	(6)
Calhoun	59,300	1.9	(8)
Cass	9,475	4.5	(3)
Charlevoix	8,750	3.3	(2)
Cheboygan	6,300	6.8	(3)
Chippewa	12,200	1.2	(1)
Clare	6,650	12.9	(6)
Clinton-Eaton-Ingham (2,7,32 cases respectively)	213,200	2.7	(41)
Crawford	4,425	3.2	(1)
Delta	13,550	2.1	(2)
Dickinson	12,500	6.8	(6)
Emmet	12,925	1.1	(1)
Genesee	165,800	4.6	(54)
Gladwin	4,250	3.4	(1)
Grand Traverse-Leelanau (6,2 cases respectively)	39,725	2.9	(8)
Gratiot	12,800	3.3	(3)
Hillsdale	12,850	7.8	(7)
Huron	11,050	3.9	(3)
Ionia	14,900	1.9	(2)
Isabella	21,425	1.3	(2)
Jackson	53,700	5.6	(21)
Kalamazoo	113,500	1.1	(9)
Kalkaska	4,150	6.9	(2)
Kent and Ottawa (28, 9 cases respectively)	358,800	1.5	(37)
Lenawee	30,400	4.2	(9)
Luce	2,225	6.4	(1)
Manistee	6,650	2.1	(1)
Marquette	27,725	2.1	(4)
Mason	9,125	1.6	(1)
Menominee	8,475	1.7	(1)
Montcalm	15,975	6.2	(7)
Muskegon	57,600	3.2	(13)
Newaygo	8,625	3.3	(2)
Ogemaw	5,125	2.8	(1)
Otsego	8,025	5.3	(3)
Sanilac	10,350	2.8	(2)
Shiawassee	17,375	1.6	(2)
St. Joseph	20,200	2.1	(3)
Tuscola	12,325	6.9	(6)
VanBuren	17,725	2.4	(3)
Washtenaw	174,800	4.6	(57)
Wexford	14,025	3.0	(3)
Saginaw-Bay-Midland (18, 9,3 cases respectively)	162,700	2.6	(30)
Detroit MSA***	1,878,100	3.8	(505)
Out of State	-	-	(9)
Unknown	-	-	(2)
All Michigan Counties	3,891,200	3-3	(915)



\*Source: MESC 1991 Annual Average Labor Statistics for Employment by Place of Work.

\*\*Rates are based on the average number of cases per year from 1989-1995, per 100,000 Michigan workers.

\*\*\*Includes Lapeer (9 cases), Livingston (17 cases), Macomb (93 cases), Monroe (5 cases), Oakland (114 cases), St. Clair (5 cases) and Wayne (262 cases) counties.

**Table 3. Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by Major Metropolitan Area  
Exposure: 1990-1995**

<u>County</u>	<b>Annual Incidence Rate*</b>					
	<b><u>1990</u></b>	<b><u>1991</u></b>	<b><u>1992</u></b>	<b><u>1993</u></b>	<b><u>1994</u></b>	<b><u>1995</u></b>
Clinton-Eaton-Ingham (2, 7, and 31 cases respectively)	1.4 (3)	3.8(8)	5.6(12)	3.7(8)	1.8(4)	2.2 (5)
Kent and Ottawa (27 and 8 cases, respectively)	2.2 (8)	1.4 (5)	0.7 (3)	1.3 (6)	3.5 (7)	1.2 (6)
Saginaw-Bay-Midland (16, 5, and 3 cases, respectively)	2.4 (4)	4.3 (7)	1.8 (3)	1.8 (4)	1.8 (3)	1.7 (3)
Detroit MSA**	3.0 (58)	2.7 (50)	4.6 (86)	6.4(121)	4.4 (85)	3.4 (69)
<b>Total (all Michigan)</b>	<b>3.6(144)</b>	<b>2.9(114)</b>	<b>3.8(150)</b>	<b>4.4(176)</b>	<b>3.7(152)</b>	<b>2.9(122)</b>

\*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 1990-1995 separately.

\*\*Includes Lapeer (9 cases), Livingston (14 cases), Macomb (89 cases), Monroe (5 cases), Oakland (100 cases), St. Clair (5 cases) and Wayne (247 cases) counties.

**Table 4. Primary Industrial Exposure for Confirmed  
Work-Related Asthma Patients: 1988-1997**

<u>Industry (SIC Code)</u>	<u>Number of Cases (1988-1997)**</u>	<u>Number of Employees***</u>	<u>Ann. Average Inc. Rate****</u>	<u>1989-1995</u>
<b>Manufacturing (20-39)</b>				
Automobile (37)	496(42-1)	282,000	19.9	(393)
Ind. and Comm. Mach. and Computer Equipment (35)	53 (4.5)	118,000	5.4	(45)
Fabricated Metal Products (34)	57 (4.8)	113,000	4.3	(34)
Chemicals and Petroleum Refining (28,29)	49 (4.1)	47,000	11.8	(39)
Rubber and Misc. Plastic Products (30)	51 (4.3)	51,000	10.9	(39)
Foundries (33)	44 (3.7)	38,000	12.8	(34)
Food and Kindred Products (20)	25 (2.1)	45,000	6.7	(21)
Printing and Publishing (27)	13 (1. 1)	45,000	3.5	(11)
Paper and Allied Products (26)	13 (1. 1)	21,000	8.2	(12)
Lumber and Wood (24)	10 (0.8)	14,000	6.1	(6)
Electrical Equipment (36)	11 (0.9)	30,000	3.3	(7)
Stone,Clay, Glass (32)	7 (0.6)	17,000	4.2	(5)
Furniture and Fixtures (25)	3 (0.2)	33,000	1.3	(3)
Apparel Made from Fabric (23)	2 (0.2)	18,000.	1.6	(2)
Other Durables (38,39)	20 (1.7)	25,000	8.6	(15)
Other Nondurables (22,3 1)	3 (0.2)	4,000	10.7	(3)
<b>Wholesale and Retail Trade (50-59)</b>				
Wholesale-Nondurable Goods (51)	8 (0.7)	2,000	1.2	(6)
Food Stores (54)	10 (0.8)	101,000	1.1	(8)
Eating and Drinking Places (58)	7 (0.6)	255,000	0.4	(7)
Wholesale-Durable Goods (50)	9 (0.8)	126,000	0.7	(6)
Automotive Dealers and Gasoline Services (55)	3 (0.2)	77,000	0.5	(3)
General Merchandise Stores (53)	3 (0.2)	116,000	0.4	(3)
Home Furniture and Furnishings (57)	1 (0.1)	28,000	0.5	(1)
<b>Services</b>				
Health (80)	85 (7.2)	315,000	2.8	(62)
Education (82)	39 (3.3)	38,000	8.6	(23)
Hotels (70)	9 (0.8)	34,000	2.9	(7)
Automotive Repair (75)	7 (0.6)	31,000	2.8	(6)
Business (73)	9 (0.8)	168,000	0.7	(8)
Social Services (83)	7 (0.6)	63,000	1.1	(5)
Engineering, Accounting, etc. (87)	5 (0.4)	77,000	0.9	(5)
Other Services (72,76,79,81,86)	17 (1.4)	207,000	1.0	(15)
<b>Construction and Mining (10-17)</b>				
Special Trade Construction (17)	22 (1.9)	87,000	3.1	(19)
Other Construction (15-16)	9 (0.8)	42,000	2.7	(8)
Mining (10-14)	4 (0.3)	9,000	4.8	(3)
<b>Miscellaneous Industries</b>				
Government (91-97)	39 (3.3)	632,000	0.8	(34)
Transportation and Utilities (40-49)	22 (1.9)	124,000	2.4	(21)
Finance, Insurance and Real Estate (60-67)	4 (0.3)	189,000	0.3	(4)
Agricultural Production (01-02)	2 (0.2)	90,000	0.3	(2)
Unknown	1 (0.1)	—	—	(1)
<b>Total</b>	<b>1179 (99.7)****</b>	<b>3,891,200</b>	<b>3.4</b>	<b>(926)</b>

\*Standard Industrial Classification.

\*\*Number of cases, percentages are in parentheses.

\*\*\*Source: MESC 1991 civilian labor force and industrial employment estimates.

\*\*\*\*Average annual incidence rate, total number of cases for 1989-1995 are in parentheses. Rates are based on average number of cases from 1989-1995 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: 1990-1995

<u>Industry (SIC code*)</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
<b>Manufacturing (20-39)</b>						
Food & Kindred Products (20)	20.0 (9)	6.7 (3)	2.3 (1)	-- (0)	2.3 (1)	4.4 (2)
Chemicals & Allied Product & Petroleum Refining (28,29)	17.0 (8)	4.3 (2)	14.0 (7)	12.0 (6)	7.8 (4)	14.3 (7)
Rubber & Misc. Plastic Products (30)	9.3 (5)	19.6 (10)	. (0)	7.3 (4)	11.3 (7)	15.1 (10)
Foundries (33)	9.5 (4)	23.7 (9)	8.1 (3)	19.4 (7)	18.9 (7)	5.4 (2)
Fabricated Metal Products (34)	6.6 (8)	4.4 (5)	2.6 (3)	3.4 (4)	5.7 (7)	3.1 (4)
Industrial & Commercial Machinery & Computer Equipment (35)	6.3 (8)	1.7 (2)	6.1 (7)	8.5 (10)	6.6 (8)	3.0 (4)
Automobile (37)	19.0 (56)	15.6 (44)	28.7 (82)	26.5 (74)	25.0 (71)	17.3 (51)
Other Durables (38,39)	19.2 (5)	8.0 (2)	4.9 (2)	9.8 (4)	-- (0)	- (0)
<b>Miscellaneous Industries</b>						
Special Trade Construction (17)	1.1 (1)	2.3 (2)	4.6 (4)	6.7 (6)	3.2 (3)	0.9 (1)
Transportation & Utilities (40-49)	0.6 (1)	1.3 (2)	1.9 (3)	4.5 (7)	2.5 (4)	1.2 (2)
Health (80)	1.6 (5)	1.9 (6)	3.4 (11)	3.6 (12)	3.8 (13)	3.7 (13)
Education (82)	5.4 (2)	5.3 (2)	8.1 (3)	21.1 (8)	7.7 (3)	10.2 (4)
Government (91-97)	8.1 (5)	6.6 (4)	7.9 (5)	14.3 (9)	6.3 (4)	1.1 (7)
<b>Total (all industries)</b>	<b>3.4(144)</b>	<b>2.8(114)</b>	<b>3.5(150)</b>	<b>4.0(176)</b>	<b>3.4(152)</b>	<b>3.0(127)</b>

\*Standard Industrial Classification.

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

Rates are based on the number of cases per 100,000adult workers in Michigan for each year separately. Source: MESCS Annual Average civilian labor force and industrial employment estimates.

**Table 6. Occupational Allergens Identified for 1179 Confirmed Work-Related Asthma Patients: 1988-1997**

<u>Allergen</u>	<u>Number</u>	<u>Percent</u>
Isocyanates	229	19.4
Metal-Working Fluids	146	12.4
Unknown (Mfg.)	76	6.4
Unknown (Office)	70	5.9
Exhaust, Smoke, Fumes	64	5.4
Welding Fumes	61	5.2
Solvent	38	3.2
Formaldehyde	36	3.0
Epoxy	33	2.8
Acrylates	27	2.3
Rubber	23	1.9
Chlorine	22	1.9
Acids	22	1.9
Styrene	19	1.6
Cobalt	18	1.5
Paint Fumes	17	1.4
Wood Dust	13	1.1
Flour	12	1.0
Chromium	11	0.9
Herbicide, Pesticide	11	0.9
Ammonia	11	0.9
Printing Inks	10	0.8
Amines	9	0.8
Caustics	8	0.7
Grain Dust	7	0.6
Pickling Ingredients	5	0.4
Animals	5	0.4
Rose Hips	4	0.3
Meat Wrappers' Asthma	4	0.3
Sulfonate	4	0.3
1, 1, 1 Trichloroethane	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
Cadmium Solder	2	0.2
Enzymes	2	0.2
Other*	<u>138</u>	<u>11.7</u>
<b>Total</b>	<b>1179</b>	<b>99.2**</b>

\*Includes: x-ray developing fluids, chemicals used in the construction industry, freon, sulfite, gas and oil refinery exposures, maleic anhydride, plastic fumes, solder fumes, vinyl acetate, ozone, zinc, textile lint, 1, 3, dichloro-2-propanol, pepper gas, cleaning solutions, exercise, weeds, soda ash, asbestos, sulfur dioxide, fiberglass, 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, cement 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, and polyethylene.

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

**Table 7. Cigarette Smoking Status of Confirmed Work-Related Asthma Patients: 1988-1997**

Smoking Status	Disease Status				
	ALL*	OA**	POA	AA	RA
Current Smoker	231(20.1)	131(23.5)	54(14.6)	24(21.6)	22(19.8)
Ex-Smoker	484(42.1)	228(40.9)	165(44.6)	37(33.3)	54(48.6)
Non-Smoker	434(37.8)	198(35.5)	151(40.8)	50(45.0)	35 (31.5)
<b>Total</b>	<b>1149</b>	<b>557</b>	<b>370</b>	<b>111</b>	<b>111</b>

\*Total number of cases: 1149. Smoking status was missing on 30 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: 1988-1997**

Family History of Allergies	Disease Status				
	<u>ALL*</u>	<u>OA**</u>	<u>POA</u>	<u>AA</u>	<u>RA</u>
YES	430(40.8)	199(38.5)	133(39.2)	55(58.5)	43(41.3)
NO	624(59.2)	318(61.5)	206(60.8)	39(41.5)	61(58.6)
<b>Total</b>	<b>1054</b>	<b>517</b>	<b>339</b>	<b>94</b>	<b>104</b>

\*Total number of cases: 1054. Missing data on 125 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: 1988-1997

<b>Personal History</b>	Disease Status				
	<b><u>ALL*</u></b>	<b><u>OA</u></b>	<b><u>POA</u></b>	<b><u>AA</u></b>	<b><u>RA</u></b>
YES	538(45.6)	237(41.8)	158(41.7)	107(89.2)	36(31.8)
NO	641(54.4)	330 (58.2)	221 (58.3)	13(10.8)	77(68.1)
<b>Total</b>	<b>1179</b>	<b>567</b>	<b>379</b>	<b>120</b>	<b>113</b>

\*Number of patients, percentages are in parentheses.

Table 10. Persistence of Symptoms and Medication  
Use in Confirmed Work-Related Asthma Patients: 1988-1997

<b><u>Exposure Status</u></b>	<b><u>Total*</u></b>	<b>Symptoms</b>		<b>Asthma Medications</b>	
		<b><u>Yes</u></b>	<b><u>Less</u></b>	<b><u>Yes</u></b>	<b><u>Less</u></b>
Still Exposed	346	330(95.4)	122(35.3)	291(84.1)	78(22.5)
No Longer Exposed	755	628(83.2)	384(50.9)	562(74.4)	227(30.1)
<b>Total</b>	<b>1101</b>	<b>958</b>	<b>506</b>	<b>853</b>	<b>305</b>

\*Total number of cases: 1101. information missing on 78 individuals. Number of patients, percentages are in parentheses.

Table 11. Status of Facilities Where 1179 Patients with  
Confirmed Work-Related Asthma were  
Exposed to Allergens: 1988-1997

<u>Inspection Status</u>	Number of Patients <u>Represented</u>	<u>Number</u>	<u>Percent</u>
Inspections	671	372*	45.9
No Follow-up Planned	361	321	39.6
Scheduled for Inspection	101	74**	9.1
Closed	29	27	3.3
No Longer Use Occupational Allergen	17	16***	2.0
<b>Total</b>	<b>1179</b>	<b>810****</b>	<b>99.9*****</b>

\*372 inspections were conducted in 331 different facilities. "Eighteen repeat inspections are planned of companies previously inspected.

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

\*\*\*\*Represents 746 different facilities.

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

Table 12. Results of 372 Industrial Hygiene Inspections in  
331 Facilities Where Patients with Confirmed  
Work-Related Asthma were Exposed to Allergens: 1988-1997

<u>Inspection Results</u>	<u>Number</u>	<u>Percent</u>
Air Sampling - NIOSH Standard		
Above NIOSH Standard	33	8.9
Below NIOSH Standard	210	56.4
No NIOSH Standard	6	1.6
Unknown (no report yet)	13	3.5
Did Not Sample for an Allergen	7	1.9
<u>Did Not Sample</u>	<u>103</u>	<u>27.7</u>
<b>Total</b>	<b>372</b>	<b>100.0</b>
Air Sampling - MIOSHA Standard		
Above MIOSHA Standard	19	5.1
Below MIOSHA Standard	229	61.5
No MIOSHA Standard	2	0.5
Unknown (no report yet)	13	3.5
Did Not Sample for an Allergen	6	1.6
<u>Did Not Sample</u>	<u>103</u>	<u>27.7</u>
<b>Total</b>	<b>372</b>	<b>99.9*</b>

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



**Table 13. Symptoms Consistent with Work-Related Asthma  
Among Fellow Workers of the 1179 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	993(18.5)	785(18.8)	185(18.5)	0(-)	23(13.5)
<u>OSHA Log***</u>	<u>237(15.9)</u>	<u>218(20.6)</u>	<u>17 (6.9)</u>	<u>2 (14.3)</u>	<u>0 (-)</u>
<b>Total</b>	<b>1230****</b>	<b>1003****</b>	<b>202</b>	<b>2</b>	<b>23</b>

\*Denominator for calculating percentages was the number of workers interviewed.

\*\*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.