

**2002**

---

**Annual Report on  
Work-Related Asthma  
in Michigan**



# **2002 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 48824-1315  
(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 30649  
Lansing, Michigan 48909-8149  
(517) 332-1608  
Douglas J. Kalinowski, MS, CIH  
Director  
Bureau of Safety and Regulation

July 16, 2003

# Summary:

This is the twelfth annual report on work-related asthma (WRA) in Michigan. For the years 1989-2000, where all reports have been processed an average of 146 new people each year have been reported to the Michigan Department of Consumer and Industry Services (MDCIS) with asthma caused or aggravated by exposures in the workplace. From 1988 to 2002, a total of 1,926 people with WRA have been identified through the Michigan Surveillance System that tracks occupational illness. Additional reports for 2001 and 2002 are still being processed. Also we know that the reports received are an under-representation of the true number of individuals with WRA in our state.

There are a number of ways to estimate the extent of WRA in a given population, ranging from the use of self-reports from surveys, to statistical estimates from studies, to an actual census count of disease. A new consensus statement from the American Thoracic Society concluded “The median value of 15% is a reasonable estimate of the occupational contribution to the population burden of asthma” (1). All of these methods to estimate the magnitude of work-related asthma in Michigan indicate that WRA is a significant problem in our state. We estimate there are 65,000 – 97,000 people in Michigan with work-related asthma.

Work place 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. Almost ninety percent of the reports received in Michigan involve the new onset of asthma. Michigan Occupational Safety and Health Act (MIOSHA) enforcement inspections at the workplaces of these individuals reveal a large number of fellow workers with asthma or respiratory symptoms compatible with asthma.

There are over 380 documented agents or work processes associated with work-related asthma. The most comprehensive listing of known causes of work-related asthma can be found on the internet at: [www.remcomp.com/asmanet/asmapro/asmawork.htm#star](http://www.remcomp.com/asmanet/asmapro/asmawork.htm#star). Known allergens such as isocyanates and metal working fluids are the most commonly reported cause of work-related asthma in Michigan, representing 16.3% and 12.1% of the Michigan WRA cases, respectively. We estimate that potentially 1% of the workforce in manufacturing in Michigan is exposed to isocyanates. However, despite the association of a patient's asthma with work, many times a known allergen is not identified. A high level of clinical suspicion for new causes of work-related asthma, therefore, is warranted among the State's health practitioners when evaluating a patient for lung disease.

Work-related asthma is affecting men and women, generally in the 30-50 year old age range. The average annual incidence rate of work-related asthma among African Americans was 2.1 times greater than among Caucasians. 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 (94% of time). The Michigan Occupational Health Standards commission has expressed an interest in reviewing the existing standard for two of these allergens: diisocyanates and latex.

This past year, the Michigan WRA surveillance team continued to work on three initiatives. All three initiatives were specifically undertaken because these exposures account for a significant number of the work-related asthma cases identified through years of tracking this disease. A manuscript on cleaning agent exposures from the four states that track work-related asthma (California, Massachusetts, Michigan and New Jersey) was published (2). Despite their wide spread use in both the workplace and the home these substances are not tested before being put on the market for their ability to cause sensitization and asthma.

The second initiative among the four states that track work-related asthma, an evaluation of work-related asthma among 305 health care workers is nearing completion. Health care workers are exposed to a number of well-documented allergens such as latex, glutaraldehyde in sterilizing/cleaning solutions, and methylmethacrylate glue used in orthopedic surgical procedures. Nurses and clerks, not housekeeping staff, were the individuals most likely to have work-related asthma. A manuscript is currently under final review before submission to a medical journal.

The third initiative we have continued to work on this past year is a Local Emphasis Program (LEP) for workers exposed to welding fume. The Michigan surveillance team continued to collect information obtained during MIOSHA enforcement inspections to better understand the types of welding fume exposures and work practices associated with WRA. To date, we have conducted 38 inspections under this LEP. Data collected from these inspections is currently being computerized to allow for analyses. We expect to complete the initial analyses on these inspections within the next year.

## **Background:**

In 1988, the Occupational Health Division of the Michigan Department of Consumer and Industry Services (formerly within 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 asthma 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 asthma 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, so that the work-relatedness of the condition can be determined.

A person is considered to have work-related asthma from sensitization to a workplace exposure if: A) they have a physician diagnosis of asthma, 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 work-related asthma. An enforcement industrial hygiene investigation at the patient's work site is conducted by MIOSHA to determine the allergen and to document its associated exposure levels. 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 work-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) (3).

After the patient is interviewed and the work-relatedness of the 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, the surveillance program 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 the telephone interview with the index case.

## **Results:**

### ***Reports***

Table 1 shows that 1,926 people were confirmed with work-related asthma between 1988 - 2002. Figure 1 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 forty-four additional patients have been confirmed since last year's report. Figure 2 shows the overlap of the 1,851 patients by reporting sources for the years 1988-2001.

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 the years 2001 and 2002. Patient interviews are still needed for three reports of patients from physicians in 2001; and for 23 reports of patients from hospitals and for six reports of patients from physicians in 2002.

## ***Gender***

Nine hundred seventy-seven (50.7%) of the persons with work-related asthma are women and 949 (49.3%) are men.

## ***Race***

One thousand four hundred seventy (76.9%) of the persons with work-related asthma are Caucasians, 348 (18.2%) are African American, 46 (2.4%) are Hispanic, 17 (0.9%) are Alaskan or American Indian, 7 (0.4%) are Asian, and 23 (1.2%) were listed as “other.” For 15 individuals, race was unknown.

The average number of incident cases of African Americans with work-related asthma each year for 1992-2000 was 29. In 1998 there were 539,621 African Americans in the Michigan labor force (4). The annual incidence rate for work-related asthma in African Americans, therefore, was 5.4/100,000 workers. The respective data for Caucasians was 115 new cases per year and 4,368,720 Caucasians in the Michigan labor force. The annual incidence rate of work-related asthma in Caucasians, therefore, was 2.6/100,000 workers. The African American rate of work-related asthma was 2.1 times greater than the rate for Caucasians.

In order to further examine the difference in the incidence rate of WRA between African Americans and Caucasians in Michigan, we looked at some of the key descriptive data collected through the surveillance system. The average year of birth, 1954 among African Americans and 1953 among Caucasians was similar. Fifty-nine percent of the African Americans were women compared to 49% among Caucasians. The type of asthma also differed: aggravated asthma was more common (15.5%) and RADS was less common (6.6%) among African-Americans than Caucasians, with 10.2% and 10.0%, respectively. African-Americans were less likely to have ever smoked cigarettes, with 51% vs. 62% having ever smoked. African-Americans were less likely to have applied for Workers’ Compensation, with 37.1% vs. 44.1%, and less likely to be awarded compensation benefits, if they did apply with 31% vs. 35%. African-Americans were more likely to still be exposed (36%) to the substance(s) believed to be causing their problem compared to Caucasians (30%). If they did leave work, African-Americans had symptoms for an average of 3.3 years before they left work as compared to 2.6 years for Caucasians. African-Americans with asthma were more likely to have worked in auto manufacturing, with 56.0% vs. 39.8%.

## ***Age***

The dates of birth range from 1905 - 1984. The average year of birth is 1953.

## ***Location in State***

Figure 3 shows the county in which the patient worked where they developed work-related asthma. The main locations are: Wayne (487 cases, 25.9%), Oakland (255 cases, 13.5%), and Macomb (180 cases, 9.6%). Table 2 and Figure 4 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 (19.4 per 100,000), Clare (12.6 per 100,000), Osceola (10.4 per 100,000), and Cheboygan (9.5 per 100,000) have the highest rates. It should be noted that, even though Luce county had the highest incidence rate of work-related asthma, the rate is based on only five cases (see Table 2). Table 3 shows the annual incidence rates for the larger metropolitan areas and the whole state for the years 1990 through 2000 separately.

### ***Type of Industry***

Table 4 shows the types of Michigan industries where the exposures to the occupational allergens occurred from 1988 to 2002. Figure 5 shows the distribution of major industry types for all cases identified from 1988-2002. The predominant industries for the total number of cases identified between 1988 and 2002 were in the manufacturing sector: automobile (42.9%), fabricated metal products (4.1%), rubber and miscellaneous plastic products (3.6%), industrial and commercial machinery and computer equipment (3.9%), and foundries (3.2%). Workers in the health field also accounted for a high percentage of the total number of patients (9.0%).

The incidence rate of work-related asthma by industry type ranges from 0.3 cases per 100,000 in restaurants to a high of 21.1 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 12.6 cases per 100,000 workers; the manufacture of other nondurables with 11.1 cases per 100,000 workers; and the manufacture of rubber products with 8.9 cases per 100,000 workers.

Table 5 shows the annual incidence rates for the 1990 through 2000 work-related cases within those industries that had 20 or more reports.

Overall, by broad industrial classification, the average annual incidence rates were: 10.6 cases per 100,000 workers in the manufacturing industry; 2.4 cases per 100,000 workers in the construction and mining industry; and 1.2 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 (16.3%), metal working fluids (12.1%), vehicle exhaust (5.6%), welding fumes (5.1%), and solvents (3.0%). The agent has not yet been identified for 278 patients (14.4%). The exposures to unknown agents occurred 154 times in the manufacturing sector and 124 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 the state average and markedly lower than that found in a blue collar working population.

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

Forty-four percent of the asthma patients had a personal history of allergies or asthma (Table 9). Three hundred forty-two (41.2%) of the 811 patients with a personal history of allergies or

asthma previously had asthma.

One thousand five hundred sixty-eight of the patients identified with work-related asthma had persistence of their asthma symptoms (Table 10). This was true for 533 of 551 (96.7%) of those still exposed as well as 1,035 of 1,181 (87.6%) no longer exposed to the substance causing their asthma. Among those no longer exposed, 51.4% stated their symptoms were less severe compared to 32.7% among those still exposed who reported their symptoms were less severe. Similarly, 86.6% of those still exposed were continuing to take asthma medications while 79.7% of those no longer exposed were still taking asthma medications. Among those no longer exposed, 30.9% stated they were taking fewer medications while only 21.1% of those still exposed were taking fewer medications (Table 10).

Eight hundred eighteen of 1,740 (47.0%) patients with known workers' compensation status had applied for workers' compensation. Cases were pending for 417 (51.0%) of those who applied, while 280 (34.2%) had received awards and 121 (14.8%) had been denied.

Although 1,926 individuals were confirmed with work-related asthma, we could find objective testing for hyperreactivity by methacholine challenge or pre- and post-bronchoprovocation for 55% of cases. In addition, we found only 1% of cases had specific antigen bronchoprovocation, 4% of cases had peak flow monitoring and only 3% of cases had pre- and post-work shift testing.

### ***Industrial Hygiene***

The 1,926 people with work-related asthma worked at 1,299 different facilities. Four hundred ninety-four facilities were inspected 568 times. Seventy-four of the 1,299 facilities were inspected more than once. Thirty-one inspections were completed since last year's report. Inspections are scheduled at 14 (1.0%) facilities (Table 11) and nine received letters notifying them that a disease report had been received and asked them to investigate potential exposures causing the respiratory problem, including indoor air problems.

Air sampling for allergens was conducted during 404 of the inspections. Fifty-nine of the 404 (14.6%) facilities were above the National Institute for Occupational Safety and Health recommended exposure limit (REL). Twenty-five (6.2%) were above the enforceable Michigan Occupational Safety and Health Act (MIOSHA) permissible exposure limit (PEL) (Table 12).

Interviews of fellow workers were performed at 439 of the 568 inspections. Workers had daily or weekly breathing symptoms or onset of new asthma since beginning to work at that company in 312 of the 439 (71.1%) companies. The average percentage of workers with symptoms in these 312 companies was 21.0%, ranging from 2% to 100%. Interviews conducted in 127 companies found no co-workers with symptoms. One thousand three hundred seventy-three of the 8,189 (16.8%) fellow workers interviewed had symptoms consistent with work-related asthma (new onset asthma or bothered at work by daily or weekly shortness of breath, wheezing or chest tightness) (Table 13).

Five hundred seventeen workers from 108 companies were listed by employers on the Michigan Occupational Safety and Health Act (MIOSHA) Injury and Illness log as having asthma or asthma-like symptoms. Eight workers had both daily or weekly breathing symptoms and were also listed on the Michigan OSHA log. Therefore, a total of 1,882 symptomatic workers were



identified during the 568 inspections.

### ***Work-Related Asthma in Health Care Workers***

The four states (California, Massachusetts, Michigan and New Jersey) that conduct surveillance for work-related asthma have identified 305 health care workers with work-related asthma from 1993-1997. Sixty-three percent worked in hospitals. In the three other states besides Michigan work-related asthma in health care workers accounted for the greatest percentage of cases; Massachusetts 32%, New Jersey 18%, and California 17%. In Michigan health care workers were the second most commonly reported occupation, 9%. Health care workers with work-related asthma were mainly women (93%).

The occupations of the cases in descending order of frequency were nurses (40%), office workers (20%), aides (14%), lab workers (11%), housekeeping and food preparation (6%), dental (4%) and other (5%). Of the 440 exposures identified in the 305 individuals, the most common exposure could not be specified and was classified as indoor air (20%), the next most common was cleaning agents (17%), then latex (14%), then paints/solvents/glues (13%) and then formaldehyde/glutaraldehyde (10%). Exposure can be reduced with substitutions of safer products and better engineering controls. Secondary prevention with early diagnosis should be routine given the presence of employee health services and the ready availability of pulmonary function equipment in hospitals.

### ***Proportion of Asthma Attributed to Work***

For the year 2001, as part of the Behavioral Risk Factor Surveillance System (BRFSS), an asthma module was included in the Michigan survey. The BRFSS is a random-digit-dialed telephone survey of the civilian, non-institutionalized population ages  $\geq 18$  years that is administered by states throughout the country. Core questions such as cigarette usage are administered in each state and then states can elect to add modules. Preliminary results from the asthma module from the 2001 BRFSS survey in Michigan are shown in Table 14. The results in Table 14 are based on the response to the following two questions: "Have you ever been told by a doctor, nurse or other health professional that you had asthma?" and "Do you still have asthma?" Almost 9% of adults in Michigan indicate they currently have asthma.

Table 15 shows the results of two questions about work-related asthma: "Were you ever told by a doctor or other medical person that your asthma was related to any job you ever had?"; and "Did you ever tell a doctor or other medical person that your asthma was related to any job you ever had?" Among individuals who currently have asthma and their asthma began as an adult, 20.1% of the men and 9.9% of the women answered yes to at least one of the two questions about the work-relatedness of asthma. For men the percentage who said they told a health care professional their asthma was related to a job was over twice as high as the men who reported that a health care provider said their asthma was work-related (18.0% vs. 7.7%).

The 2000 year census counted 9,938,444 people in Michigan of whom 7,344,510 were 18 years or older. Applying the most recent BRFSS data, that 8.8% of Michigan adults currently have asthma would translate into 646,317 adults in Michigan who have asthma. The Michigan BRFSS survey suggests that there is an association with work in 9.7% (95 %CI 6.7-12.9) of the Michigan adults who currently have asthma (Table 15). This translates into 62,693 (95% CI

43,303-83,375) adults with asthma in Michigan where the healthcare provider or the patient report an association with work. If a male develops asthma as an adult, the latest data from BRFSS suggests that either he or his health care provider will attribute the new onset asthma as work-related 20% of the time. Estimates from the published literature on the percentage of adult asthma which is work-related range from 2-45% with a median of 9%. Calculation of the estimate using the most methodologically sound articles would suggest that 15% of adult asthma is work-related (5). A recent consensus document from the American Thoracic Society also concluded that 15% was a reasonable estimate (1). Applying the 15% to the BRFSS estimate of 650,000 Michigan adults with asthma would translate into approximately 97,000 adults in Michigan with work-related asthma.

Using a technique called capture-recapture, another estimate of the extent of work-related asthma in Michigan suggests that the average of 146 reports received by the MDCIS each year represents 18.2% - 64.0% (228-801) of the true number of adults who develop new onset asthma caused by exposure at work (5).

### ***Michigan Workforce Exposed to Isocyanates***

Isocyanates are the most commonly reported cause of work-related asthma in Michigan. The United States Environmental Protection Agency (EPA) requires reporting by facilities that use any one of 650 different chemicals in amounts greater than 10,000 pounds per year and are a manufacturer, mining or electrical generator and have at least 10 employees. Isocyanate are one of the 650 substances for which reporting is required. Queries of reportable chemicals can be generated to identify state-level statistics on facilities.

We identified Michigan's isocyanate-using companies in the Toxic Release Inventory to estimate the number of workers potentially exposed to isocyanates in the state. This estimate under-counts non-manufacturing exposed workers such as auto body paint shop employees since the EPA database does not include these types of non-manufacturing establishments. On the other hand it is an over-count of manufacturing employees since the total number of employees at a given manufacturing facility that reported isocyanates were counted even though only a smaller percentage of the workers would have directly worked with and therefore have been potentially exposed to isocyanates.

A list of counties with the companies that reported the use of isocyanates in calendar year 2000 (the most recent year for which this information is available) can be found in Table 16. The number of employees potentially exposed to isocyanates, the total number of workers in these counties, and the percentage of workers potentially exposed to isocyanates is listed.

## **Discussion:**

In our previous annual reports, we have emphasized the fact that the cases reported in Michigan's surveillance system are likely an under count of the true number of cases of work-related asthma in the state. This continues to be true. Studies suggest that work exposures are important etiologic agents in a significant percentage (15%) of adults with asthma (1,5).

An average of 146 new people each year are reported to the Michigan Department of Consumer

and Industry Services (MDCIS) with confirmed work-related asthma. Based on responses from the 2001 BRFSS random sample of Michigan residents, we would estimate that there are a total of 62,693 (43,303 - 83,375) Michigan adults with work-related asthma in the state. Based on the medical literature we would estimate that there are 97,500 Michigan adults with work-related asthma (1,5). Using capture-recapture analysis we estimate 228 - 801 adults in Michigan develop work-related asthma each year (6).

As in the previous annual reports on work-related asthma in Michigan, the workers reported are generally young to middle age Caucasians men and women, with the greatest number being reported from the Detroit metropolitan area. The rate of work-related asthma in African Americans is 2.1 times greater than among Caucasians. A number of differences between African Americans and Caucasians with work-related asthma were noted: 59% of the African Americans vs 49% of the Caucasians with WRA are women; 16% of the African Americans vs 10% of the Caucasians reported having aggravated asthma; 7% of the African Americans vs 10% of the Caucasians reported having RADS; 51% of the African Americans vs 62% of the Caucasians reported having ever smoked cigarettes; 37% of the African Americans vs 44% of the Caucasians reported having applied for workers' compensation, and if they applied, 31% of the African Americans vs 35% of the Caucasians reported being awarded workers' compensation; 36% of the African Americans vs 30% of the Caucasians reported being still exposed to the substances causing their symptoms; waiting 3.3 years for African Americans vs 2.6 years for Caucasians before leaving the job where they were exposed to the substances causing their symptoms; and 56% of the African Americans vs 40% of the Caucasians reported having worked in auto manufacturing. Studies on asthma in the general population find African-Americans having a higher morbidity and mortality from asthma. Work-related asthma factors noted in the surveillance data that would contribute to greater morbidity among African-Americans include being more likely to be still exposed, having a longer time of exposure before leaving work, and being less likely to receive workers' compensation.

Individuals in the Michigan work force tend to develop their asthma from exposures to agents in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. The predominant causes of work-related asthma remain isocyanates (16.3%) and metal-working fluids (12.1%). We have added a new table (Table 16) this year on the number of manufacturing workers potentially exposed to isocyanates. In some counties 5% or more of the workforce may be exposed to isocyanates in manufacturing facilities: Montcalm (10%); Barry (8%); Mecosta (7%); Wexford-Missaukee (6%); Cass (5%); and Dickinson (5%). Health care providers can use this information to heighten their awareness of potential exposure to isocyanates among their patients with asthma. We will consider ways to refine these estimates on isocyanates in future years and expand the listing to include more asthma-causing agents.

Asthma symptoms persist despite removal from the precipitating work exposures (Table 10). Studies have shown that the sooner an individual is removed from the exposure causing their asthma after symptoms develop, the more likely the individual's symptoms will resolve (5). On the average among the 1,181 individuals no longer exposed, 2.7 years elapse from time of 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.

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 (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 1,373 fellow workers with symptoms compatible with work-related asthma. Five hundred seventeen individuals were listed on the Michigan OSHA log as having work-related asthma. There was only an overlap of eight individuals, although one might expect a greater overlap of the co-workers with symptoms to be reported on the 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. This indicates the need for more companies to implement medical surveillance programs. 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 may not be sufficiently protective to ensure a safe workplace.

Reevaluations of some of the allowable exposure standards may be needed. These reevaluations might 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 (7). The Occupational Health Standards Commission has indicated an interest in looking at the need for new standards for the Diisocyanates and latex.

The percentages of individuals reported with work-related asthma for whom this surveillance system could document as having had breathing tests performed in relation to work is less than 10%. This reflects the standard of medical care in the United States where the diagnosis of work-related asthma is made from patient history. More frequent use of objective pulmonary function testing performed in relation to work would allow health care providers to feel more confident about advising their patients to leave their exposure. Cessation of exposure is the most important aspect of treatment of work-related asthma. Patients who are removed from exposure the soonest have the best prognosis (7).

The Michigan Chapter of the American Lung Association under contract to the Michigan Department of Community Health maintains a web site of resources on asthma called the Michigan Asthma Communication Network (MACN). The web site can be accessed at: [www.getasthmahelp.com](http://www.getasthmahelp.com). Information on work-related asthma is included on this web site. Given the potential that 15% or more of adults with asthma have work-related asthma, work-related asthma needs to be integrated into all asthma initiatives planned on surveillance and education, both for health care providers and the public.

The Michigan work-related asthma surveillance team continued to work on several important initiatives this past year on cleaning agents and welding fumes, two of the most common causes of work-related asthma in Michigan. The cleaning agent initiative resulted in a published manuscript describing the data from the four states currently conducting surveillance for work-related asthma: California, Massachusetts, Michigan and New Jersey (2). Based on an

examination of the characteristics and trends associated with cleaning agent exposures, we also developed an educational brochure on preventing cleaning agent exposures that can lead to work-related asthma. It is available on the MACN website as well as on the MSU website: [www.chm.msu.edu/oem](http://www.chm.msu.edu/oem).

The second initiative involves a Local Emphasis Program (LEP) for welding fumes. This program continues to identify workplaces with welding fume exposures during MIOSHA enforcement inspections. Collection of information during these inspections is still being carried out and will allow us to better understand the factors most associated with the development of breathing problems and work-related asthma from welding fume exposures. To date, 38 inspections have been completed under this LEP. Both of these initiatives will further our goal toward reducing the burden of occupational diseases in Michigan.

A third initiative that the Michigan surveillance team worked on, in collaboration with California, Massachusetts and New Jersey involved analysis of health care worker exposures and asthma. A manuscript is being finalized for submission to a medical journal.

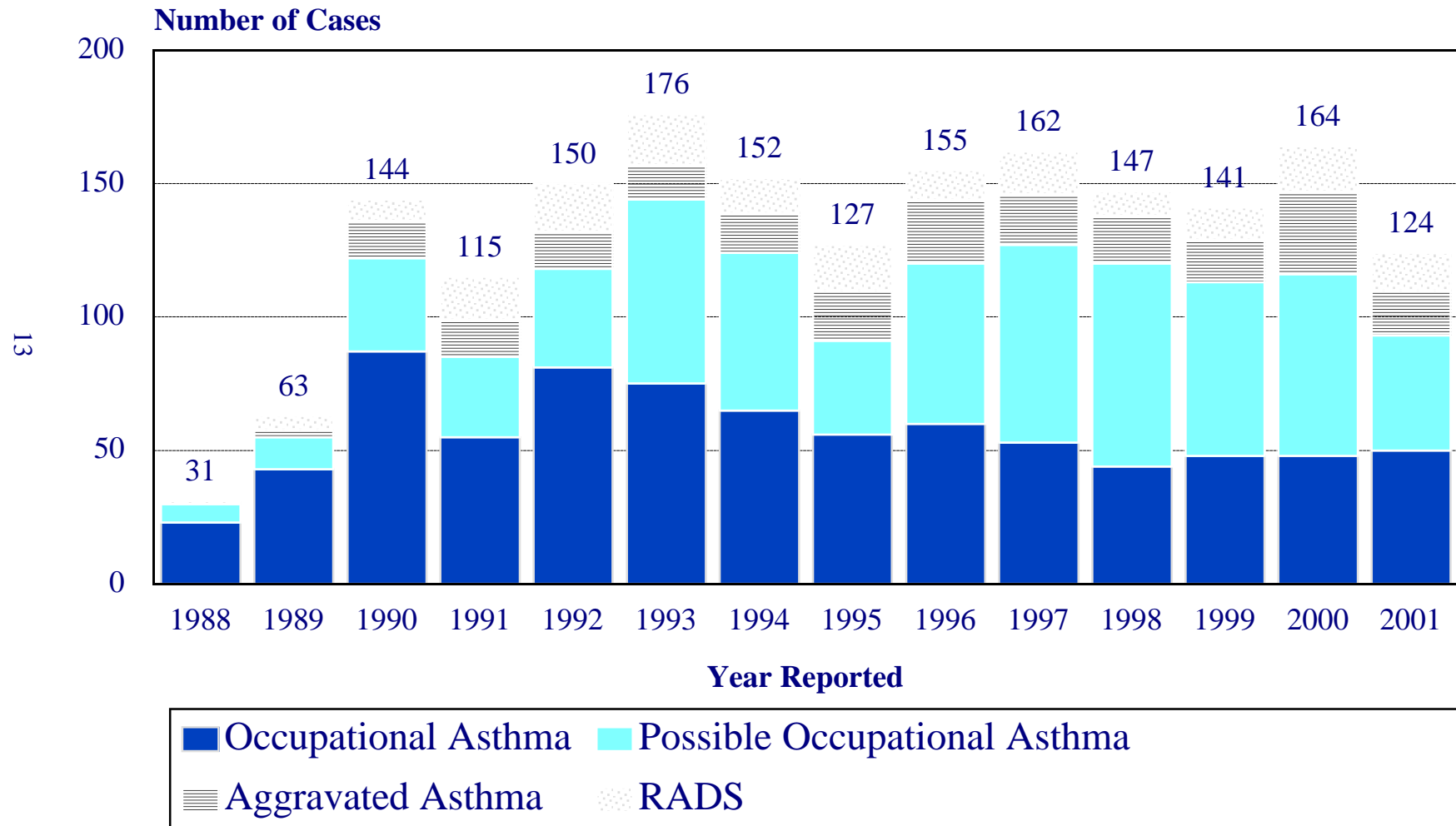
The report of a patient with known or suspected work-related asthma is a sentinel health event that is critical to effective occupational disease surveillance. Case reporting from physicians offers the opportunity for the most timely workplace interventions, compared to receiving reports from hospitals.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

# References

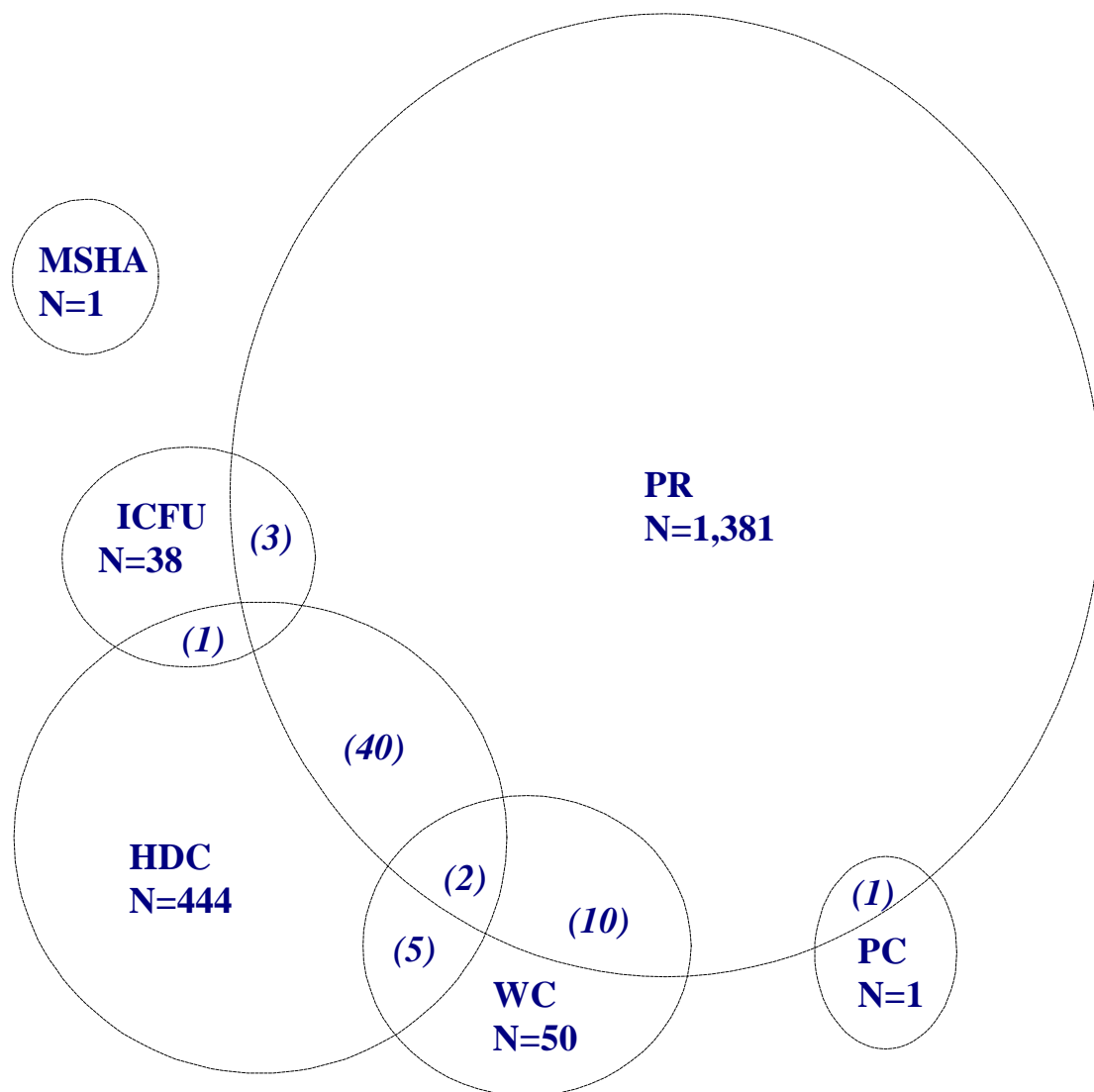
1. American Thoracic Society. Occupational Contribution to the Burden of Airway Disease. *American Journal Respiratory and Critical Care Medicine* 2003; 167:787-797.
2. Rosenman KD, Reilly MJ, Schill DP, Valiante D, Flattery J, Harrison R, Reinisch F, Pechter E, Davis L, Tumpowsky CM, Filios M. Cleaning Products and Work-related Asthma. *Journal of Occupational and Environmental Medicine* 2003; 45:556-563.
3. 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.
4. Michigan Department of Career Development (MDCD), Employment Service Agency. *Affirmative Action Information Report: Michigan 1999.* Detroit, MI. Office of Labor Market Information.
5. Blanc PD, Toren KJ. *How Much Adult Asthma can be Attributed to Occupational Factors?* *American Journal of Medicine* 1999; 107: 580-587.
6. Henneberger PK, Kreiss K, Rosenman KD, Reilly MJ, Chang YF, Geidenberger CA. *An Evaluation of the Incidence of Work-Related Asthma in the United States.* *International Journal of Occupational and Environmental Health* 1999; 5:1-8.
7. 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-CCU502998-16.*

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



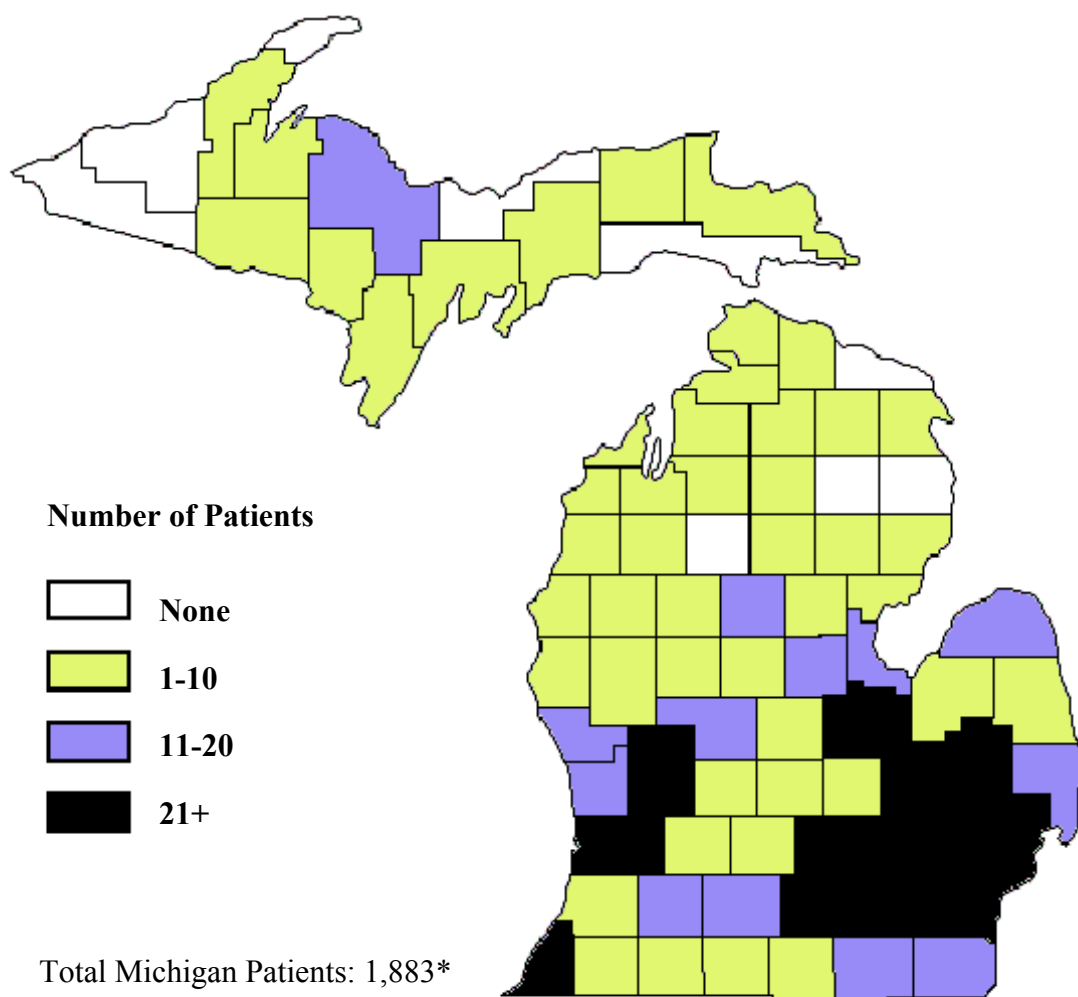
**Figure 2. Overlap of Reporting Sources for Confirmed Work-Related Asthma Patients: 1988-2001\***



\* Diagram represents 1,851 individuals initially reported from 1988-2001. 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; WC=Workers' Compensation; ICFU=Index Case Follow-Up; MSHA=Mine Safety and Health Administration; PC=Poisson Control Center.



**Figure 3. Distribution of Confirmed Work-Related Asthma Patients by County of Exposure: 1988-2002**



**Oakland and Wayne** counties had the highest number of work-related asthma patients, with 255 and 487 individuals, respectively.

\*County of exposure was unknown for 12 patients. Thirty-one patients were exposed out-of-state to an allergen.

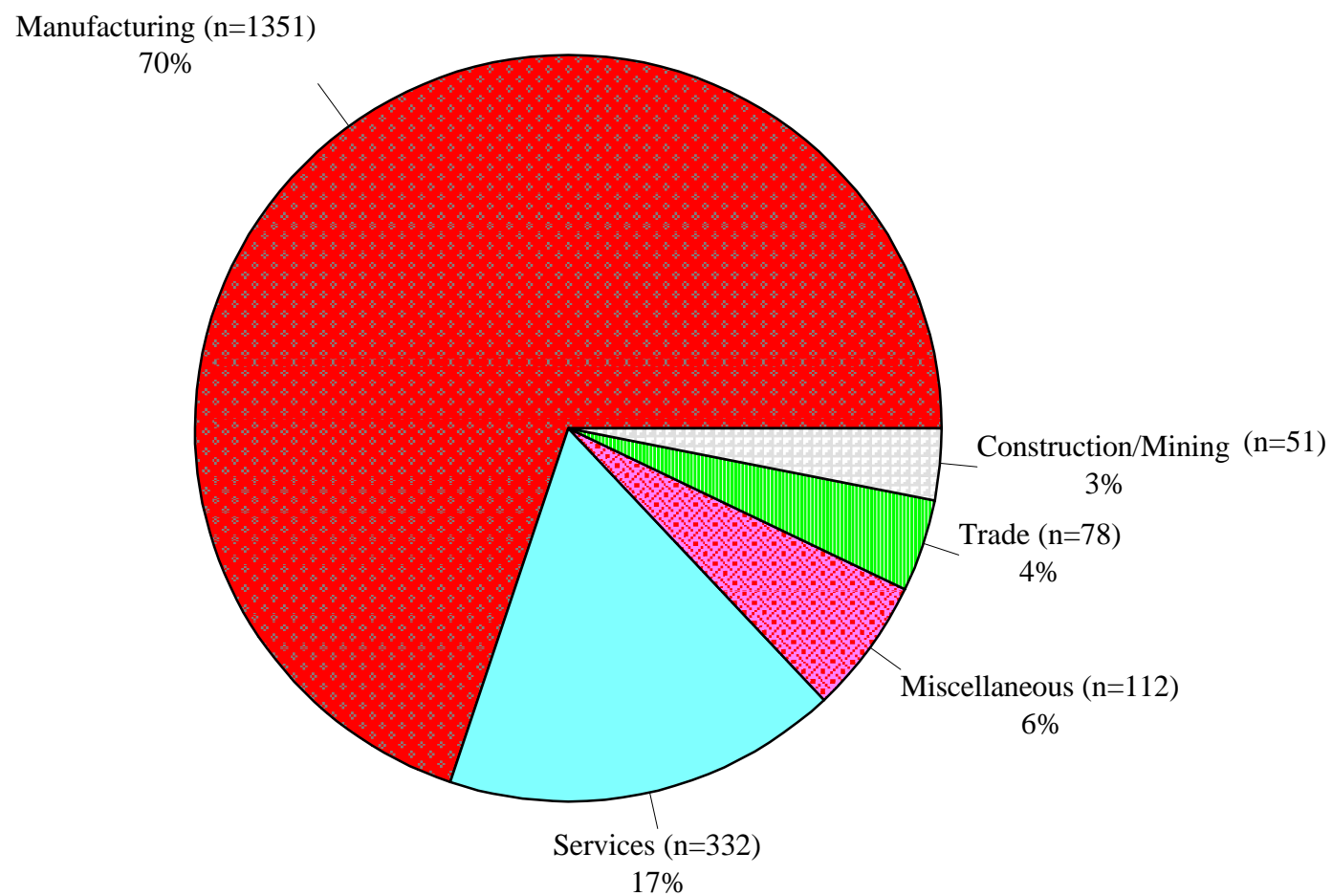
**Overall Rate for Michigan:**  
**3.4 per 100,000**

**Rate per 100,000**

- None
- <6
- 6-10
- >10

16

**Figure 5. Major Industry Type for  
Confirmed Work-Related Asthma Patients: 1988-2002\***



\*Number of patients in parentheses, percent below.

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

<u><b>YEAR</b></u>	<b>Disease Status*</b>				<u><b>TOTAL</b></u>
	<u><b>OA</b></u>	<u><b>POA</b></u>	<u><b>AA</b></u>	<u><b>RA</b></u>	
<b>1988</b>	23	7	0	1	31
<b>1989</b>	43	12	3	5	63
<b>1990</b>	87	35	14	8	144
<b>1991</b>	55	30	14	16	115
<b>1992</b>	81	37	14	18	150
<b>1993</b>	75	69	13	19	176
<b>1994</b>	65	59	15	13	152
<b>1995</b>	56	35	19	17	127
<b>1996</b>	60	60	24	11	155
<b>1997</b>	53	74	19	16	162
<b>1998</b>	44	76	18	9	147
<b>1999</b>	48	65	16	12	141
<b>2000</b>	48	68	31	17	164
<b>2001</b>	50	43	17	14	124
<b>2002</b>	27	39	4	5	75
<b>Total</b>	815	709	221	181	1,926

\*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: 1989-2000**

<b>County</b>	<b>Number of Employees</b>	<b>Avg. Annual Inc. Rate**</b>	<b>Total # Cases 1989-2000</b>
Alcona and Iosco (0, 2 cases respectively)	10,050	1.7	2
Alpena	12,200	2.0	3
Antrim	5,000	3.3	2
Arenac	4,300	3.9	2
Baraga	3,275	5.1	2
Berrien	68,800	2.3	19
Branch	12,600	6.0	9
Cass	10,375	2.4	3
Charlevoix	9,450	3.5	4
Cheboygan	7,025	9.5	8
Chippewa	14,650	1.7	3
Clare	7,275	12.6	11
Clinton-Eaton-Ingham (4, 9, 47 cases respectively)	217,000	2.3	60
Crawford	4,475	3.7	2
Delta	14,100	1.8	3
Dickinson	13,125	5.7	9
Emmet	14,000	1.2	2
Genesee	167,800	6.7	134
Gladwin	4,675	1.8	1
Grand Traverse-Benzie-Kalkaska-Leelanau (10, 2, 5, 3 cases respectively)	53,875	3.1	20
Gratiot	13,400	3.1	5
Hillsdale	14,475	4.6	8
Houghton-Keweenaw (1,0 cases respectively)	14,075	0.6	1
Huron	11,500	8.0	11
Ionia	15,025	5.0	9
Iron	3,825	2.2	1
Isabella	21,650	1.5	4
Jackson	56,800	4.1	28
Kalamazoo-Calhoun-VanBuren (14, 15, 4 cases respectively)	198,700	1.4	33
Kent-Ottawa-Muskegon-Allegan (42, 15, 17, 19 cases respectively)	479,600	1.6	93
Lake	1,725	4.8	1
Luce	2,150	19.4	5
Manistee	6,950	1.2	1
Marquette	28,750	3.2	11
Mason	10,375	0.8	1
Menominee	9,000	0.9	1
Montcalm	17,675	4.2	9
Montmorency	2,225	3.7	1
Newaygo	9,350	3.6	4
Ogemaw	5,725	1.5	1
Osceola	7,225	10.4	9
Otsego	9,200	8.2	9
Sanilac	11,825	4.2	6
Schoolcraft	2,625	3.2	1
Shiawassee	19,550	1.7	4
St. Joseph	23,275	1.8	5
Tuscola	13,500	6.2	10
Washtenaw-Lenawee-Livingston (107, 13, 23 cases respectively)	248,000	4.8	143
Wexford-Missaukee (3, 0 cases respectively)	16,150	1.5	3
Saginaw-Bay-Midland (53, 11, 14 cases respectively)	168,300	3.9	78
Detroit, MSA***	1,928,000	3.7	863
Out of State	---	---	26
Unknown	---	---	12
<b>All Michigan Counties</b>	<b>4,099,000</b>	<b>3.4</b>	<b>1,696</b>

\*Source: MESC 1994 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 1989-2000, per 100,000 Michigan workers. \*\*\* MSA=Metropolitan Statistical Area and includes Lapeer (21 cases), Macomb (157 cases), Monroe (15 cases), Oakland (225 cases), St. Clair (14 cases) and Wayne (431 cases) counties.

**Table 3. Annual Incidence Rates of Work-Related Asthma Among  
Michigan Workers by Major Metropolitan  
Area: 1990-2000**

	<u>Clinton-Eaton- Ingham</u>	<u>Kent-Ottawa- Muskegon-Allegan</u>	<u>Saginaw-Bay- Midland</u>	<u>Detroit MSA**</u>	<u>Total (all Michigan)</u>
<b>1990</b>	1.4 (3)	2.2 (8)	2.4 (4)	3.0 (58)	3.6 (144)
<b>1991</b>	3.8 (8)	1.4 (5)	4.3 (7)	2.7 (50)	3.0 (115)
<b>1992</b>	5.6 (12)	0.7 (3)	1.8 (3)	4.6 (86)	3.8 (150)
<b>1993</b>	3.7 (8)	1.3 (6)	1.8 (4)	6.4 (121)	4.4 (176)
<b>1994</b>	1.8 (4)	3.5 (7)	1.8 (3)	4.4 (85)	3.7 (153)
<b>1995</b>	2.2 (5)	1.2 (6)	1.7 (3)	3.4 (69)	3.0 (127)
<b>1996</b>	1.3 (3)	0.9 (5)	2.9 (5)	4.0 (91)	3.5 (154)
<b>1997</b>	2.2 (5)	1.1 (6)	4.5 (8)	3.7 (77)	3.6 (162)
<b>1998</b>	2.6 (6)	1.4 (8)	3.9 (7)	3.7 (79)	3.3 (147)
<b>1999</b>	0.9 (2)	1.7 (10)	5.5 (10)	2.7 (59)	3.1 (141)
<b>2000</b>	1.3 (3)	1.5 (9)	8.7 (16)	3.0 (66)	3.6 (164)

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

Source: MESG Annual Average Labor Statistics for Employment by Place of Work, for each year 1990-1999 separately.

\*\*MSA=Metropolitan Statistical Area. For the years 1990-1995, includes Lapeer, Livingston, Macomb, Monroe, Oakland, St. Clair, and Wayne counties. For 1996, 1997, 1998, 1999 and 2000 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: 1988-2002**

<u>Industry (SIC Code)*</u>	<u>Number of Cases</u> <u>1988-2002**</u>		<u>Number of</u> <u>Employees***</u>	<u>Ann. Average</u> <u>Inc. Rate****</u> <u>1989-2000</u>	
<b>MANUFACTURING (20-39)</b>					
Automobile (37)	826	(42.9)	284,000	21.1	(718)
Fabricated Metal Products (34)	79	(4.1)	122,000	5.1	(74)
Ind. & Comm. Mach. & Computer Equipment (35)	76	(3.9)	121,000	4.7	(68)
Rubber and Misc. Plastic Products (30)	70	(3.6)	62,000	8.9	(66)
Foundries (33)	62	(3.2)	37,000	12.6	(56)
Food and Kindred Products (20)	38	(2.0)	43,000	6.4	(33)
Printing and Publishing (27)	18	(0.9)	44,000	3.0	(16)
Lumber and Wood (24)	17	(0.9)	16,000	8.3	(16)
Paper and Allied Products (26)	16	(0.8)	21,000	6.0	(15)
Electrical Equipment (36)	14	(0.7)	31,000	3.5	(13)
Furniture and Fixtures (25)	8	(0.4)	36,000	1.9	(8)
Apparel Made from Fabric (23)	2	(0.1)	19,000	0.9	(2)
Other Durables (32,38,39)	48	(2.5)	43,000	8.3	(43)
Other Nondurables (22,28,29,31)	77	(4.0)	51,000	11.1	(68)
<b>WHOLESALE AND RETAIL TRADE (50-59)</b>					
Wholesale-Durable Goods (50)	15	(0.8)	125,000	0.9	(13)
Wholesale-Nondurable Goods (51)	14	(0.7)	74,000	1.1	(10)
Eating and Drinking Places (58)	12	(0.6)	270,000	0.3	(11)
Food Stores (54)	11	(0.6)	103,000	0.9	(11)
Automotive Dealers and Gasoline Services (55)	9	(0.5)	78,000	1.0	(9)
General Merchandise Stores (53)	7	(0.4)	123,000	0.5	(7)
Miscellaneous Retail (52, 56, 57,59)	10	(0.5)	186,000	0.4	(8)
<b>SERVICES</b>					
Health (80)	174	(9.0)	338,000	3.8	(154)
Education (82)	64	(3.3)	371,000	1.1	(51)
Business (73)	15	(0.8)	222,000	0.5	(14)
Automotive Repair (75)	11	(0.6)	35,000	2.4	(10)
Social Services (83)	10	(0.5)	77,000	1.0	(9)
Engineering, Accounting, etc. (87)	9	(0.5)	85,000	0.7	(7)
Other Services (70,72,76,79,81,86,89)	49	(3.3)	263,000	1.4	(43)
<b>CONSTRUCTION AND MINING (10-17)</b>					
Special Trade Construction (17)	39	(2.0)	94,000	2.7	(31)
Other Construction (15-16)	8	(0.4)	46,000	1.4	(8)
Mining (10-14)	4	(0.2)	9,000	3.7	(4)
<b>MISCELLANEOUS INDUSTRIES</b>					
Government (91-97)	55	(2.9)	639,000	0.6	(49)
Transportation and Utilities (40-49)	32	(1.7)	159,000	1.5	(29)
Finance, Insurance and Real Estate (60-67)	13	(0.7)	195,000	0.4	(9)
Agricultural Production and Services (01,02,07)*****	8	(0.4)	36,683	1.6	(7)
Unknown	6	(0.3)	—	—	(6)
<b>TOTAL</b>	<b>1926</b>		<b>4,099,000</b>	<b>3.4</b>	<b>(1696)</b>

\*Standard Industrial Classification.

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

\*\*\*Source:MESC 1994 civilian labor force and industrial employment estimates.

\*\*\*\*Average annual incidence rate, total number of cases for 1989-2000 are in parentheses. Rates are based on average number of cases from 1989-2000 per 100,000 adult workers in each industrial category.

\*\*\*\*\*Source: Michigan Department of Career Development, Statewide Average Monthly Industry Employment, 1994.

**Table 5. Primary Industrial Exposure for Confirmed  
Work-Related Asthma Patients: 1990-2000**

<b><u>INDUSTRY (SIC code*)</u></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>	<b><u>1996</u></b>	<b><u>1997</u></b>	<b><u>1998</u></b>	<b><u>1999</u></b>
<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)	6.8 (3)	4.9 (2)	7.5 (3)	2.6 (1)
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)	*** (3)	*** (7)	*** (5)	10.2 (5)
Rubber & Misc. Plastic Products (30)	9.3 (5)	19.6 (10)	-- (0)	7.3 (4)	11.3 (7)	15.1 (10)	10.4 (7)	13.2 (9)	4.5 (3)	5.8 (4)
Foundries (33)	9.5 (4)	23.7 (9)	8.1 (3)	19.4 (7)	18.9 (7)	5.4 (2)	18.9 (7)	8.1 (3)	10.5 (4)	7.9 (3)
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)	8.6 (11)	4.7 (6)	1.6 (2)
Industrial & Commercial Machinery & Computer Equipment (35)	6.3 (8)	1.7 (2)	6.1 (7)	8.5 (10)	6.6 (8)	3.0 (4)	3.0 (4)	2.2 (3)	3.7 (5)	2.3 (3)
Automobile (37)	19.0 (56)	15.6 (44)	28.7 (82)	26.5 (74)	25.0 (71)	17.3 (51)	21.1 (59)	21.1 (61)	23.7 (65)	23.9 (65)
Other Durables (38,39)	19.2 (5)	8.0 (2)	4.9 (2)	9.8 (4)	-- (0)	-- (0)	6.7 (3)	4.4 (2)	6.5 (3)	8.9 (4)
<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)	1.7 (2)	0.8 (1)	2.4 (3)	2.3 (3)
Transportation & Utilities (40-49)	0.6 (1)	1.3 (2)	1.9 (3)	4.5 (7)	2.5 (4)	1.2 (2)	-- (0)	0.6 (1)	0.6 (1)	1.7 (3)
Health (80)	1.6 (5)	1.9 (6)	3.4 (11)	3.6 (12)	3.8 (13)	3.7 (13)	3.3 (12)	6.3 (23)	6.0 (22)	4.6 (17)
Education (82)	0.6 (2)	0.6 (2)	0.8 (3)	2.2 (8)	0.8 (3)	1.1 (4)	2.1 (8)	2.3 (9)	1.3 (5)	0.3 (1)
Government (91-97)	8.1 (5)	6.6 (4)	7.9 (5)	14.3 (9)	6.3 (4)	1.1 (7)	0.8 (5)	0.5 (3)	0.5 (3)	0.2 (1)
<b>Total (all industries)</b>	3.4 (144)	2.8 (114)	3.5 (150)	4.0 (176)	3.4 (152)	3.0 (127)	3.3 (152)	3.2 (161)	3.0 (147)	3.4 (141)

\*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, 1997, 1998, 1999 and 2000.



**Table 6. Occupational Agents Associated with 1,926 Confirmed Work-Related Asthma Patients: 1988-2002**

<u>Allergen</u>	<u>Number</u>	<u>Percent</u>
Isocyanates	314	16.3
Metal-Working Fluids	233	12.1
Unknown (Mfg.)	154	8.0
Unknown (Office)	124	6.4
Cleaning Solutions	121	6.3
Exhaust, Smoke, Fumes	108	5.6
Welding Fumes	98	5.1
Solvents	58	3.0
Latex/Rubber	51	2.6
Epoxy	48	2.5
Formaldehyde	47	2.4
Paint Fumes	44	2.3
Acrylates	34	1.8
Acids	34	1.8
Chlorine	30	1.6
Cobalt	26	1.3
Styrene	20	1.0
Wood Dust	19	1.0
Plastic Fumes	19	1.0
Flour	18	0.9
Ammonia	15	0.8
Chromium	13	0.7
Herbicide, Pesticide	12	0.6
Printing Inks	11	0.6
Amines	10	0.5
Fiberglass	10	0.5
Grain Dust	9	0.5
Animals	9	0.5
Caustics	8	0.4
Meat Wrappers' Asthma	7	0.4
Pickling Ingredients	6	0.3
Cement Dust	6	0.3
Glutaraldehyde	6	0.3
1,1,1 Trichloroethane	5	0.3
Cosmetology Chemicals	5	0.3
Rose Hips	4	0.2
Sulfonate	4	0.2
Sulfur Dioxide	4	0.2
Nitrogen	4	0.2
Colophony	3	0.2
Photo Developing Fluids	3	0.2
Phthalic Anhydride	3	0.2
Cadmium Solder	3	0.2
Enzymes	3	0.2
Nickel	2	0.1
Other *	161	8.4
<b>Total</b>	<b>1,926</b>	<b>100.3*</b>

\*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, lactase, medications, sodium acetate, cellulose, glaze, sulfuric acid, aspirin, tetrahydrofuran, zinc borate, leather, rust inhibitor, citrus spray, mold release, sand, hydrogen sulfide, teflon, flux, natural gas, tuberculosis vaccine, fungus, gortex, hydrogen peroxide, sludge, premicide, chlorpyrifos, psyllium, lavender soap, perfume, copper oxide, asphalt, propylene, blue prints, soot and hair remover.

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

**Table 7. Cigarette Smoking Status of Confirmed Work-Related Asthma Patients: 1988-2002**

<b><u>Smoking Status</u></b>	<b>Disease Status</b>				
	<u>ALL</u> *	<u>OA</u> **	<u>POA</u>	<u>AA</u>	<u>RA</u>
Current Smoker	374 (20.0)	175 (21.9)	109 (15.8)	42 (20.4)	48 (27.6)
Ex-Smoker	750 (40.1)	315 (39.4)	296 (42.9)	66 (32.0)	73 (42.0)
Non-Smoker	746 (39.9)	310 (38.8)	285 (41.3)	98 (47.6)	53 (30.5)
<b>Total</b>	<b>1870</b>	<b>800</b>	<b>690</b>	<b>206</b>	<b>174</b>

\*Total number of cases: 1870. Smoking status was missing on 56 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: 1988-2002**

<b>Family History of Allergies</b>	<b>Disease Status</b>				
	<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	719 (42.2)	294 (39.5)	267 (42.2)	100 (57.8)	58 (38.2)
NO	983 (57.8)	451 (60.5)	365 (57.8)	73 (42.2)	94 (61.8)
<b>Total</b>	<b>1702</b>	<b>745</b>	<b>632</b>	<b>173</b>	<b>152</b>

\*Total number of cases: 1702. Missing data on 224 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: 1988-2002**

<b><u>Personal History</u></b>	<b>Disease Status</b>				
	<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	854 (44.3)	309 (37.9)	286 (40.3)	200 (90.5)	59 (32.6)
NO	1072 (55.7)	506 (62.1)	423 (59.7)	21 (9.5)	122 (67.4)
<b>Total</b>	<b>1926</b>	<b>815</b>	<b>709</b>	<b>221</b>	<b>181</b>

\*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: 1988-2002**

<b><u>Exposure Status</u></b>	<b><u>Total*</u></b>	<i>Breathing Problems Still Present</i>		<i>Still Taking Asthma Medications</i>	
		<b><u>Yes</u></b>	<b><u>Less</u></b>	<b><u>Yes</u></b>	<b><u>Less</u></b>
Still Exposed	551	533 (96.7)	180 (32.7)	477 (86.6)	116 (21.1)
No Longer Exposed	1181	1035 (87.6)	607 (51.4)	941 (79.7)	365 (30.9)
<hr/>					
<b>Total</b>	<b>1732</b>	<b>1568</b>	<b>787</b>	<b>1418</b>	<b>481</b>

\*Total number of cases: 1732. Information missing on 194 individuals. Number of patients, percentages are in parentheses.

**Table 11. Status of Facilities Where 1,926 Patients with  
Confirmed Work-Related Asthma were  
Exposed to Allergens: 1988-2002**

<b><u>Inspection Status</u></b>	<b><u>Number of Patients Represented</u></b>	<b><u>Number</u></b>	<b><u>Percent</u></b>
Inspections	926	568*	41.4
No Follow-up Planned	836	654	47.6
Scheduled for Inspection	17	14	1.0
Closed	45	41	3.0
No Longer Use Occupational Allergen	23	22**	1.6
Sent Company an Indoor Air Letter	30	26	1.9
Sent Company a Letter to Check Exposures	49	48	3.5
<b>Total</b>	<b>1,926</b>	<b>1,373***</b>	<b>100.0</b>

\*568 inspections were conducted in 494 different facilities.

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

\*\*\*Represents 1,299 different facilities.

**Table 12. Results of 568 Industrial Hygiene Inspections in 494 Facilities Where Patients with Confirmed Work-Related Asthma were Exposed to Allergens: 1988-2002**

<u>Inspection Results</u>	<u>Number</u>	<u>Percent</u>
Air Sampling - NIOSH Standard		
Above NIOSH Standard	59	10.4
Below NIOSH Standard	334	58.8
No NIOSH Standard	11	1.9
Unknown (no report yet)	3	0.5
Did Not Sample for an Allergen	10	1.8
<u>Did Not Sample</u>	<u>151</u>	<u>26.6</u>
<b>Total</b>	<b>568</b>	<b>100.0</b>
Air Sampling - MIOSHA Standard		
Above MIOSHA Standard	25	4.4
Below MIOSHA Standard	377	66.4
No MIOSHA Standard	3	0.5
Unknown (no report yet)	3	0.5
Did Not Sample for an Allergen	9	1.6
<u>Did Not Sample</u>	<u>151</u>	<u>26.6</u>
<b>Total</b>	<b>568</b>	<b>100.0</b>

**Table 13. Symptoms Consistent with Work-Related Asthma  
Among Fellow Workers of the 1,926 Confirmed  
Work-Related Asthma Patients**

	<b>Disease Status of Index Patient</b>				
<b><u>Symptoms*</u></b>	<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>
Daily or Weekly SOB, Wheezing or Chest Tightness	1373 (16.8)	1039 (17.4)	299 (15.2)	4 (16.0)	31 (13.5)
<b><u>OSHA Log***</u></b>	517 (19.0)	388 (22.6)	118 (13.2)	2 (12.5)	9 (10.5)
<b>Total</b>	<b>1890****</b>	<b>1427***</b>	<b>417</b>	<b>6</b>	<b>40</b>

\*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. Prevalence of Lifetime and Current, Childhood and Adult Onset Asthma by Gender**

**2001 Michigan BRFSS\***

	<b><u>Total</u></b>	<b><u>Males</u></b>	<b><u>Females</u></b>
Lifetime asthma	12.4 ±1.2**	10.5 ±1.8	14.1 ±1.6
Lifetime asthma, child onset	5.7 ±0.9	6.5 ±1.5	4.9 ±1.1
Lifetime asthma, adult onset (≥16y)	6.2 ±0.8	3.5 ±1.0	8.7 ±1.3
Current asthma	8.8 ±1.0	6.7 ±1.5	10.8 ±1.5
Current asthma, child onset	3.5 ±0.7	3.7 ±1.2	3.4 ±0.9
Current asthma, adult onset (≥16y)	5.0 ±0.7	2.9 ±0.9	7.0 ±1.2

\*Behavioral Risk Factor Surveillance System.

\*\*Percentages with 95% confidence interval limits.

**Table 15. Proportion of Individuals Whose Asthma May be Work-Related, by Gender**

**2001 Michigan BRFSS\***

	<u><b>Doctor</b></u>	<u><b>Respondent</b></u>	<u><b>Either</b></u>
Lifetime asthma	4.9 ±1.8**	5.8 ±2.2	8.1 ±2.5
Lifetime asthma, child onset	2.4 ±1.9	2.5 ±2.1	3.6 ±2.4
Lifetime asthma, adult onset (≥16y)	7.3 ±3.1	9.2 ±4.0	12.5 ±4.4
Current asthma	5.8 ±2.3	7.0 ±2.9	9.7 ±3.2
Current asthma, child onset	3.4 ±2.9	4.0 ±3.3	5.3 ±3.7
Current asthma, adult onset (≥16y)	7.3 ±3.3	9.3 ±4.6	12.7 ±4.9
<b>Males</b>			
Lifetime asthma	5.4 ±3.2	7.7 ±4.4	9.8 ±4.8
Current asthma	6.1 ±4.0	10.4 ±6.4	12.6 ±6.8
Child onset	3.6	4.9	5.7
Adult onset (≥16y)	7.7	18.0	20.1
<b>Females</b>			
Lifetime asthma	4.7 ±2.2	4.6 ±2.3	7.1 ±2.7
Current asthma	5.6 ±2.8	5.1 ±2.8	8.1 ±3.3
Child onset	3.3	3.2	4.9
Adult onset (≥16y)	7.1	6.0	9.9

\*Behavioral Risk Factor Surveillance System.

\*\*Percentages with 95% confidence interval limits.

**Table 16. Michigan Workers Exposed to Isocyanates  
by County, in Calendar Year 2000**

<b>County</b>	<b># Potentially Exposed to <u>Isocyanates**</u></b>	<b>Total # Workers <u>in County***</u></b>	<b>% Potentially Exposed to <u>Isocyanates</u></b>
<b>Allegan, Kent, Muskegon, Ottawa</b>	11,349	590,600	2
	<b>Company*</b>		
	American Seating		
	Brunswick Bowling		
	Counter Point Furniture		
	Donnelly		
	G P M		
	H B Fuller		
	Haworth		
	Herman Miller		
	Howard Miller		
	Johnson Controls		
	Johnson Controls Interiors		
	Knape & Vogt		
	Magic Finishing		
	Meridian Auto Systems		
	Steelcase		
	Tiara Yachts		
	Wolverine World Wide		
<b>Barry</b>	1,040	13,550	8
	Bradford White		
<b>Bay, Saginaw, Midland</b>	7,405	183,100	4
	Bay Cast		
	Delphi Saginaw Steering		
	Eaton Corporation		
	Glastender		
	GMC Saginaw Metal		
	Lendell Manufacturing		
<b>Berrien</b>	2,800	73,900	4
	Bosch Braking		
	Comcast Urethane		
	Hayes Albion		
	Leco		
	Tyler Refrigeration		

<b>Branch</b>		25	15,375	<1
<b>Calhoun, Kalamazoo, Van Buren</b>	Acore Door	1,353	218,100	1
	Arvco Container			
	Azon USA			
	Cello-Foil			
	Degussa Construction			
	Eliason			
	Special-lite			
<b>Cass</b>		600	11,625	5
<b>Charlevoix</b>	Georgie Boy Manufacturing	500	11,475	<1
	East Jordan Iron Works			
<b>Clare</b>		300	8,350	4
<b>Dickinson</b>	Renosol	720	14,750	5
	Grede Foundries			
	Louisiana Pacific			
<b>Eaton, Clinton, Ingham</b>		430	239,900	<1
	ASC Lansing Trim			
	Axson			
	Collins & Aikman			
	Vantico			
<b>Genesee</b>		500	170,700	<1
<b>Hillsdale</b>	Delphi Energy and Chassis Flint East	200	17,125	1
<b>Isabella</b>	Dow	850	29,575	3
	Delfield			
<b>Jackson</b>	Randell Manufacturing	729	64,000	1
	International Foam and Trim			
	Michigan Seat			
	Tac Manufacturing			
<b>Kalkaska, Benzie, Grand Traverse, Leelanau</b>		499	63,125	1
	Eagle Trim			

**Lapeer, Macomb, Monroe, Oakland,  
St. Clair, Wayne**

14,236

2,182,000

1

Armaly Sponge  
Auto Alliance  
Autolign Manufacturing  
BASF  
Collins & Aikman  
Daimler-Chrysler Jefferson Assembly  
Delta-ha  
Du Pont  
H P Pelzer  
International Casting  
ITW Foamseal  
Johnson Controls  
Lear  
Lymantal International  
M & H Industries  
Perma-Fix of Michigan  
Plastomer  
Recticel  
Romeo Rim  
Takata Petri  
Tool Chemical  
US Farathane  
Visteon  
Visteon Utica  
Wayne Disposal  
Wolverine Bronze  
Woodbridge

**Lenawee, Livingston, Washtenaw**

5,780

285,800

2

Anderson Development  
Brighton Interiors  
Collins & Aikman  
Package Design & Manufacturing  
Pilkington Clinton  
Tecumseh Products  
TRW Kelsey Hayes  
Versatrim

<b>Mason</b>	Visteon Saline Woodbridge	300	11,275	3
<b>Mecosta</b>	Great Lakes Casting	999	13,975	7
<b>Montcalm</b>	Wolverine World Wide	2,110	20,425	10
<b>Ogemaw</b>	Electrolux Refrigerator Division Northland Corporation	200	6,700	3
<b>Sanilac</b>	Taylor Building Products	150	13,600	1
<b>Shiawassee</b>	Numatics	140	21,300	1
<b>Upper Peninsula</b>	Vaungarde	760	133,500	1
<b>Wexford, Missaukee</b>	Emerson Tool Louisiana Pacific	1,080	19,525	6
<b>TOTAL</b>	Four Winns Cruiser Four Winns Sport Hayes Lemmerz	55,055	4,604,000	1

\*Source: U. S Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2000 (report generated March 7, 2003).

\*\*Source: Michigan Manufacturer's Directory, 2000.

\*\*\*Source: Michigan Department of Career Development/Employment Service Agency. Annual Average 2000 Area Labor Statistics, Total Wage and Salary Employment by Place of Work (February 16, 2001).