1999

Annual Report on Silicosis in Michigan

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A Joint Report
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June 12, 2000

Summary:

This is the ninth annual report on silicosis in Michigan. The report is based on partial data for 1985 and 1986, complete data for the years 1987 through 1997 and preliminary data for 1998 and 1999. A total of 789 cases of silicosis have been confirmed from 1985-1999; 62 of those reports were newly confirmed in 1997.

The disease continues to occur mainly among men born before 1940 who began working in a Michigan ferrous foundry in the 1930s or 1940s and worked there over 25 years. Forty-four percent of the patients are African American. The overall annual average incidence rate of silicosis among African American males (14.6 cases per 100,000) is almost seven times higher than white males (2.1 cases per 100,000). The rates within specific counties ranged between 2.2 to 25.4 times higher for African American males than the rates for white males. Exposure to silica occurred mainly in companies in the counties of Muskegon, Saginaw and Wayne.

The mortality rate for silicosis in the Muskegon area is one of the highest in the country.

The patients identified with silicosis generally have severe disease. Twenty-five percent have progressive massive fibrosis (PMF) and another 33.7% have advanced simple silicosis. Only about a third of all patients have normal breathing tests. Twenty percent had been told they had tuberculosis (includes both clinical disease or a positive skin test). Individuals with silicosis in Michigan have an increase of over 300% in the likelihood of dying from non-malignant respiratory disease, both restrictive and obstructive, and an 80% increase in the likelihood of dying from lung cancer (1).

Despite the severity of disease, 56% of the patients with known filing status had not applied for workers' compensation. The percentage of patients applying has decreased in recent years.

Although silicosis typically occurs after a long duration of exposure to silica, there continue to be patients who develop silicosis after a relatively short time because of the severity of exposure. One individual developed silicosis who began working with silica in the 1990s, 5 in the 1980's, 31 in the 1970s and 98 in the 1960s. Exposure to silica is still occurring in foundries, although working conditions have clearly improved from the 1930s and 1940s.

Construction is the other major industry in Michigan where exposure to silica continues to occur. There are 101 companies in the state that are continuing to do abrasive blasting with silica rather than a less hazardous non-silica abrasive. Further effort is needed to improve their work practices and encourage them to switch to a non-silica abrasive.

Background:

Silicosis is a chronic, progressive lung disease resulting from exposure to respirable particles of silica sand. Irreversible changes in the lung cause increasingly debilitating breathing difficulties among individuals who develop silicosis. Despite the fact that lung disease secondary to dusty work conditions from exposure to silica sand has been described since antiquity, workers continue to be exposed to hazardous levels of silica in industry and suffer from this preventable disease.

Michigan has required the reporting of all known or suspected occupational diseases including silicosis since 1978 under part 56 of Public Act 368 of 1978. Active surveillance of silicosis, however, began in 1987. In that year, the Michigan Department of Consumer and Industry Services (MDCIS) with financial assistance from the National Institute for Occupational Safety and Health (NIOSH) instituted a surveillance/investigation program for silicosis.

Michigan's surveillance program identifies individuals with known or suspected silicosis, interviews the patients or their next-of-kin about their work and health history using a standardized telephone-administered questionnaire, and obtains medical records including the most recent chest x-ray. The information on each patient is reviewed by a physician who is board-certified in both internal and occupational medicine. A person is considered to have silicosis if there is: (1) a history of exposure to silica; and (2) a chest x-ray interpretation showing rounded opacities of 1/0 or greater profusion per the International Labor Office (ILO) classification system for pneumoconiosis, or a biopsy report of lung tissue showing the characteristic silicotic nodule. All chest x-rays are reviewed by a physician who is a NIOSH certified "B" reader, and therefore has special training and accreditation to interpret chest x-rays for all pneumoconioses, including silicosis. If the facility where the patient was exposed to silica is still in operation, a Michigan Occupational Safety and Health Act (MIOSHA) enforcement inspection may be conducted to determine current exposures and conditions.

Michigan uses numerous sources to identify persons with silicosis: (1) reports from hospitals; (2) reports from physicians; (3) death certificates; and (4) claims awarded by the Michigan Silicosis, Dust Disease and Logging Industry Compensation Fund. Each year, data from the Michigan Health and Hospital Association's (MHA) Michigan inpatient database are obtained to verify the completeness of reporting by the hospitals.

Results:

Reports

Due to delays in receiving reports and the availability of data bases, the most complete data available are for 1987-1997. Partial data is also available for the years 1985 and 1986. We do not receive complete reporting from the hospitals until one and a half years and death certificates until half a year after the end of the calendar year. Accordingly, 1998 and 1999 data is incomplete at this time. Given the known inadequacies of occupational disease surveillance systems and under-diagnosis of the condition itself, even the most complete data for the years 1987-1997 is an underestimate of the true number of persons diagnosed with silicosis.

Figure 1 shows 706 patients identified and confirmed with silicosis through the surveillance system by year for 1987 through 1997. To date, we have confirmed an additional 21 persons with silicosis in 1998, and 5 in 1999. Table 1 shows the primary reporting source of the 789 persons confirmed with silicosis for the years 1985 - 1999. Hospital reports are the primary source of identification of patients, with 58% of silicosis patients identified solely through the hospitals. Often a patient will be reported to the system by more than one source. Figure 2 shows the overlap of reporting sources for the most complete reporting years of 1987 through 1998.

A study in New Jersey of a similar type of surveillance system estimated that the system received reports on only one-third of individuals diagnosed with silicosis (2). Using capture-recapture analyses, we estimate the true number of silicotics in Michigan from 1987-1995 is 2,483 (3). During this same period 577 individuals were reported to the state. This is 23% of the estimated total number of individuals developing the disease during these 9 years.

The following statistics are based on the 789 cases of silicosis confirmed from 1985-1999.

Gender

Seven hundred seventy-one (97.7%) of the persons with silicosis are men; the other 18 (2.3%) are women.

Race

Three hundred forty-three (43.8%) of the persons with silicosis are African American, 415 (53.0%) are white, two (0.3%) are of Asian ancestry, one (0.1%) was of American Indian ancestry, and 22 (2.8%) were listed as "other ancestry". The race on six individuals was unknown.

Age

The distribution of the decade of birth is shown in Figure 3. The average year of birth is 1919, ranging from 1888 to 1959.

Decade of Hire

The distribution of the decade of hire is shown in Figure 4. The average year of hire is 1946, ranging from 1910 to 1996.

Duration of Work

The distribution of years worked at a silica exposed job is shown in Figure 5. The average number of years worked is 27.5.

Location in State

Figure 6 shows the counties in which the patients' silica exposure occurred. The locations are clustered in 3 counties: Muskegon, Saginaw and Wayne. The overall average annual incidence rates for silicosis among African American men is 14.6 cases per 100,000, and for white men is 2.1 cases per 100,000. Figure 7 shows the average annual incidence rate of silicosis among African American men age 40 and greater in each county. The rate in Shiawassee was 866/100,000, in Muskegon it was 285/100,000, in Saginaw it was 98/100,000, in Monroe it was 51/100,000, in Calhoun it was 38/100,000, in St. Clair it was 22/100,000, and in Macomb it was 26/100,000. Figure 8 shows the annual average incidence rate of silicosis among white men age 40 or greater in each county. The rate in Muskegon was 25/100,000, in Keewanaw it was 19/100,000, in Alpena it was 17/100,000, in Saginaw it was 13/100,000, and in Menominee it was 15/100,000.

Type of Industry

Table 2 shows the primary type of industry where the silica exposure occurred. The predominant industry where individuals developed silicosis is iron foundries (78.6%). One hundred eighty-eight (25.4%) people stated they had done sandblasting as part of their work.

Medical Results

Overall 545 (69.1%) of the people with silicosis had simple silicosis and 200 (25.3%) had progressive massive fibrosis. Twenty-three (2.9%) silicotics had normal x-rays with biopsy evidence. Twenty-one (2.7%) individuals had x-ray reports which were consistent with silicosis but which could not be classified.

Two hundred seventeen (27.9%) of the people with silicosis never smoked cigarettes, 453 (58.2%) had quit, 108 (13.9%) were still smoking and no information was available on 11 individuals. Figure

9 shows the distribution of x-ray results according to the ILO classification and smoking. Non smokers tended to have more severe silicosis. The greater percentage of non smokers with progressive massive fibrosis was statistically significant (30.0% non smokers vs. 20.4% current smokers vs. 24.5% ex smokers) ($X^2 = 31.005$, $p = .002$). This latter finding may be an artifact of our reporting system which is mainly based on reports of hospitalized individuals. Non-smoking individuals with simple silicosis are less likely to be symptomatic and less likely to be hospitalized and therefore less likely to have been reported.

Tables 3 and 4 show the distribution of forced vital capacity (FVC) and the ratio of forced expiratory volume in one second (FEV_1) to FVC by x-ray and cigarette smoking status. Approximately 60% of people with silicosis had reduced breathing function, either restrictive or obstructive. Obstructive changes were found in two thirds of the individuals who had ever smoked cigarettes and half of the individuals who had never smoked cigarettes.

The age-adjusted mortality rate for silicosis from 1982-1993 for men and women 15 years of age and older in the Muskegon area was in the top 10 percent in the country (9).

Silica exposure causes a number of diseases in addition to silicosis (Table 5). We have previously reported an increase in rheumatoid arthritis, systemic lupus erythematosis and scleroderma among individuals reported to the Michigan silicosis registry (8). This past year we reviewed their renal function status. Ten percent of the individuals had some mention of chronic kidney disease in their medical record and 33% had serum creatinines greater than 1.5mg/dl (10). As with the connective tissue disease cases, no association was found between duration of exposure or the amount of scarring on the chest x-ray and the presence of kidney disease or elevated serum creatinine. These results are consistent with the presumed immunological etiology. We are aware of one individual with Anti-neutrophil cytoplasmic antibody (ANCA) positive chronic renal failure among the individuals in the Michigan silicosis registry. ANCA positive renal disease has been repeatedly associated with silica exposure (11).

Workers' Compensation

Since the 1930s, there has been special concern about the incidence of silicosis in Michigan. Michigan foundries were thought to be at severe economic risk from the large number of workers who might apply for workers' compensation for silicosis. Initially, a cap was placed on the amount of an award a patient with silicosis could receive. In 1966, the cap was replaced by a special assessment on all insurance companies and self-insured employers who provide workers' compensation. The funds from this special assessment are used to limit the liability of silica using industries.

Only 291 (44.1%) of the individuals with known filing status with silicosis or their next of kin applied for workers' compensation. Three hundred sixty-nine (55.9%) had not applied. It was unknown whether the remaining 129 people with silicosis applied for compensation. There was no association

between severity of disease and whether or not a person applied for workers' compensation. Of those known to apply, 238 (81.8%) received compensation, 18 (6.2%) had been denied, and 35 (12.0%) were pending.

Industrial Hygiene Results

The 789 individuals with silicosis were exposed to silica in 291 facilities (Table 6). Inspections were performed at 69 (23.7%) of these facilities. Currently four (1.4%) facilities are scheduled for an inspection. One hundred four (35.7%) facilities were no longer in operation, 46 (15.8%) were located out of state, 20 (6.9%) facilities no longer used silica, 27 (9.3%) had worked at multiple construction sites as building trade workers, 1 (0.3%) was referred to and inspected by the Mine Safety and Health Administration since the company was out of MIOSHA jurisdiction, and 20 (6.9%) were unknown.

Air sampling was conducted in 49 of the 69 facilities inspected (Table 7). Thirty-one of 49 (63.3%) facilities were above the National Institute for Occupational Safety and Health recommended exposure level for silica. Twenty-one of the 49 (42.9%) were above the enforceable Michigan Occupational Safety and Health Act (MIOSHA) standard for silica. Another one (2.0%) company was above the MIOSHA standard for beryllium and one company was above the MIOSHA standard for silica and silver.

Only 6 of the 60 (10.0%) facilities where the medical surveillance program was evaluated provided medical screening for silicosis for its workers which included a periodic chest x-ray interpreted by a "B" certified reader, while two companies provided periodic chest x-rays that were not interpreted by a "B" certified reader. Nineteen (31.7%) only performed pre-employment testing, 22 (36.7%) provided no medical surveillance, and 15 (25.0%) performed annual or biannual pulmonary function testing without chest x-rays.

Discussion:

The predominant characteristics of the individuals reported during Michigan's eleven years of silicosis

surveillance are that they are elderly men who mainly worked in foundries in three counties. The age distribution is similar to that reported in the 1950s and does not indicate the disease is disappearing (6). The older age of the patient (average year of birth, 1919) is secondary to the chronic nature of the disease and the typical long exposure to silica which is required to develop the disease (average 28 years of exposure to silica). However, we continue to receive reports of individuals with short term exposure and onset of work in the 1970s, 1980s and one in the 1990's. Fifty-four or 7.1% worked for less than 10 years. Thirty-seven (4.8%) began work in the 1970s, 1980s or 1990's; fourteen of these individuals had worked for less than 10 years. The people with silicosis who began work in the 1970s or 1980s were more likely to have done sandblasting than those who began work with silica before 1970 (45% vs. 31%). Of the six people who first were exposed to silica in the 1980's or 1990's; 2 worked in foundries, 2 were buffing and polishing metal, 1 was a heavy equipment operator who did excavating and one 1 did cement work.

African American men are over represented (43.8%). This reflects previous hiring practices in foundries. In fact, among the counties where rates were compared between African American and white workers (see Figures 7 and 8), African American workers consistently had higher incidence rates of silicosis than their white counterparts. Overall for the state, the incidence rate of silicosis among African American workers was 14.6 per 100,000 versus 2.1 per 100,000 for white workers (an almost 7 fold greater incidence).

The individuals reported generally have advanced disease: 200 (25.3%) have progressive massive fibrosis; another 266 (33.7%) have advanced simple silicosis (category 2 or 3). Over 60% of the reported patients have reduced breathing tests. These include both restrictive and obstructive changes. Obstructive changes although more prevalent among individuals who had smoked cigarettes, were found in half of the individuals who had never smoked cigarettes (Table 4). Individuals with silicosis are developing pulmonary hypertension, clinically significant bronchitis and chronic obstructive pulmonary disease (7). Twenty percent have had either tuberculosis or have had a positive skin test indicating infection with the mycobacteria that causes tuberculosis. Despite the severity of their disease, 56% had not applied for workers' compensation.

Hospitals are the primary reporting source of the patients through this surveillance system. These hospitalized patients are generally the sicker and older patients with silicosis. In contrast, surveillance systems in Ohio and Wisconsin received more reports directly from physicians and consequently had a higher proportion of younger individuals with less advanced disease (4). In recent years, the Michigan surveillance system has been receiving reports at an earlier stage in the individual's disease. This is reflected in the decrease over time in the number of reports first received through death certificate review and a corresponding increase, though small, in the number of reports received directly from physicians (Table 1).

Individuals with silicosis have an increased morbidity and mortality for both malignant and non-malignant respiratory disease (1,7). The increased risk for death is found both in patients who ever or never smoked cigarettes (1). Individuals with silicosis also have an increased risk of developing connective tissue disease, particularly Rheumatoid Arthritis (8) and chronic renal disease,

particularly ANCA positive disease (10,11).

Because the number of Michigan ferrous foundry workers peaked in the 1970s at around 40,000, dropped to around 20,000 in 1980 and then to 12,000 in the late 1980s, there are fewer workers today at risk of developing silicosis. Combined with improved working conditions this should reduce the number of foundry workers who develop silicosis.

One hundred and one abrasive blasting companies in Michigan continue to use silica abrasives. This is down from 204 companies in 1995. A survey of a sample of companies using silica found that most of them are putting their employees at risk of developing silicosis because they are not following recommended and required work practices. European countries banned the use of silica for sandblasting 40 years ago. Further initiatives to encourage the use of silica substitutes are needed.

Industrial hygiene inspections reveal violations of the exposure standard for silica in 42.9% of the facilities where sampling was done. However, follow-up inspections of these same companies have shown a significant decrease in silica exposures. Those companies not in compliance with the silica standard are requiring their workers to use powered air purifying respirators or air line respirators. However, because of an inadequate or absent medical surveillance program in 91.3% of the facilities, there is no way to monitor the adequacy of the controls.

Silicosis remains an ongoing problem in Michigan with former foundry workers continuing to develop severe disease. Further, some Michigan workers will continue to be at risk of developing silicosis because of inadequate controls at foundries currently in operation. The Federal Occupational Safety and Health Administration is in the process of proposing a new silica standard. In addition, sandblasting continues to be a high risk operation (5). Given the ready availability of non-silica abrasives, further educational and regulatory efforts are needed to encourage the replacement of silica in blasting operations or at the minimum ensure that silica is used properly. A report from NIOSH highlights that continued reminders and reviews of work places are needed as long as silica continues to be used in industry (5).

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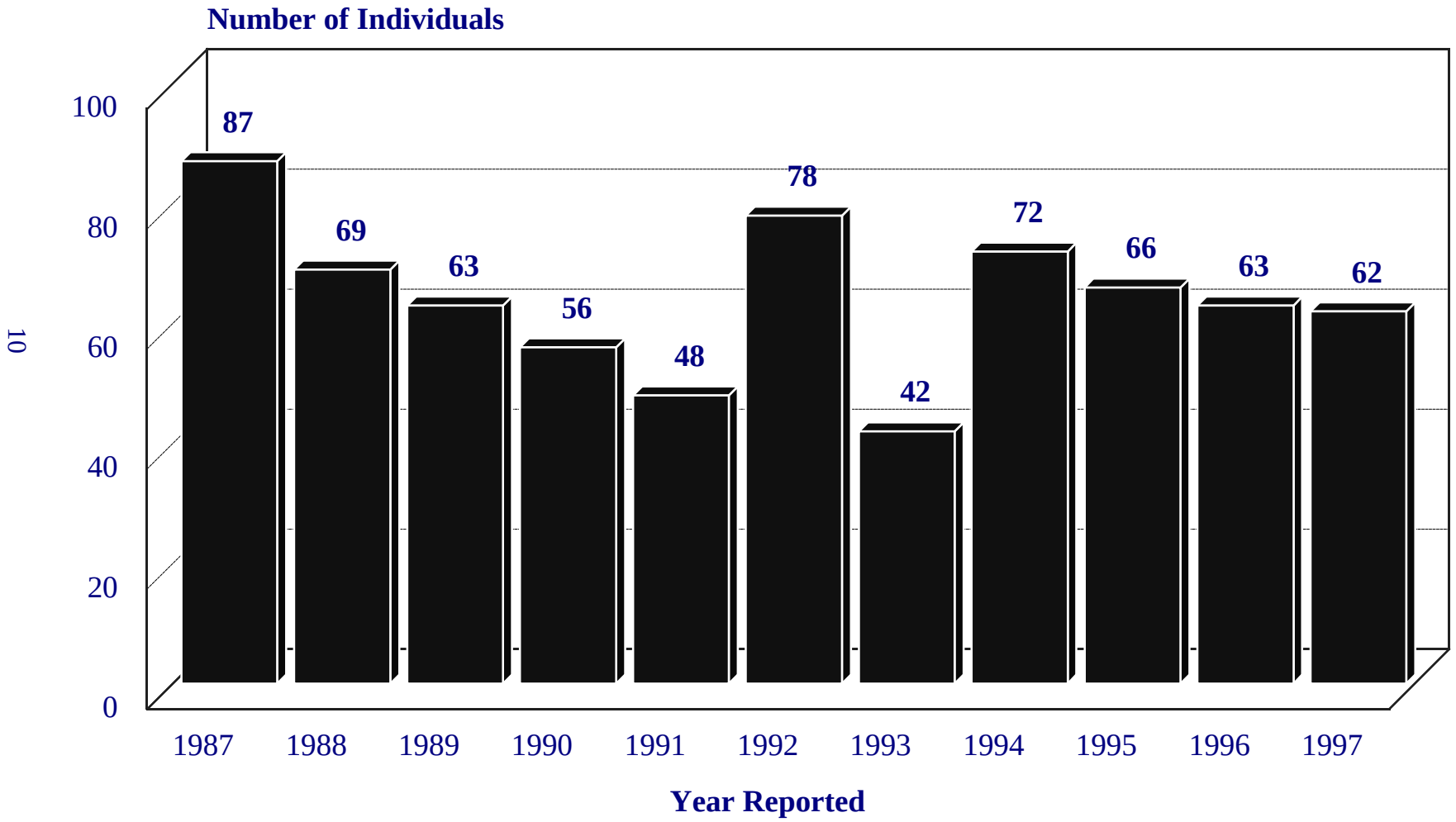
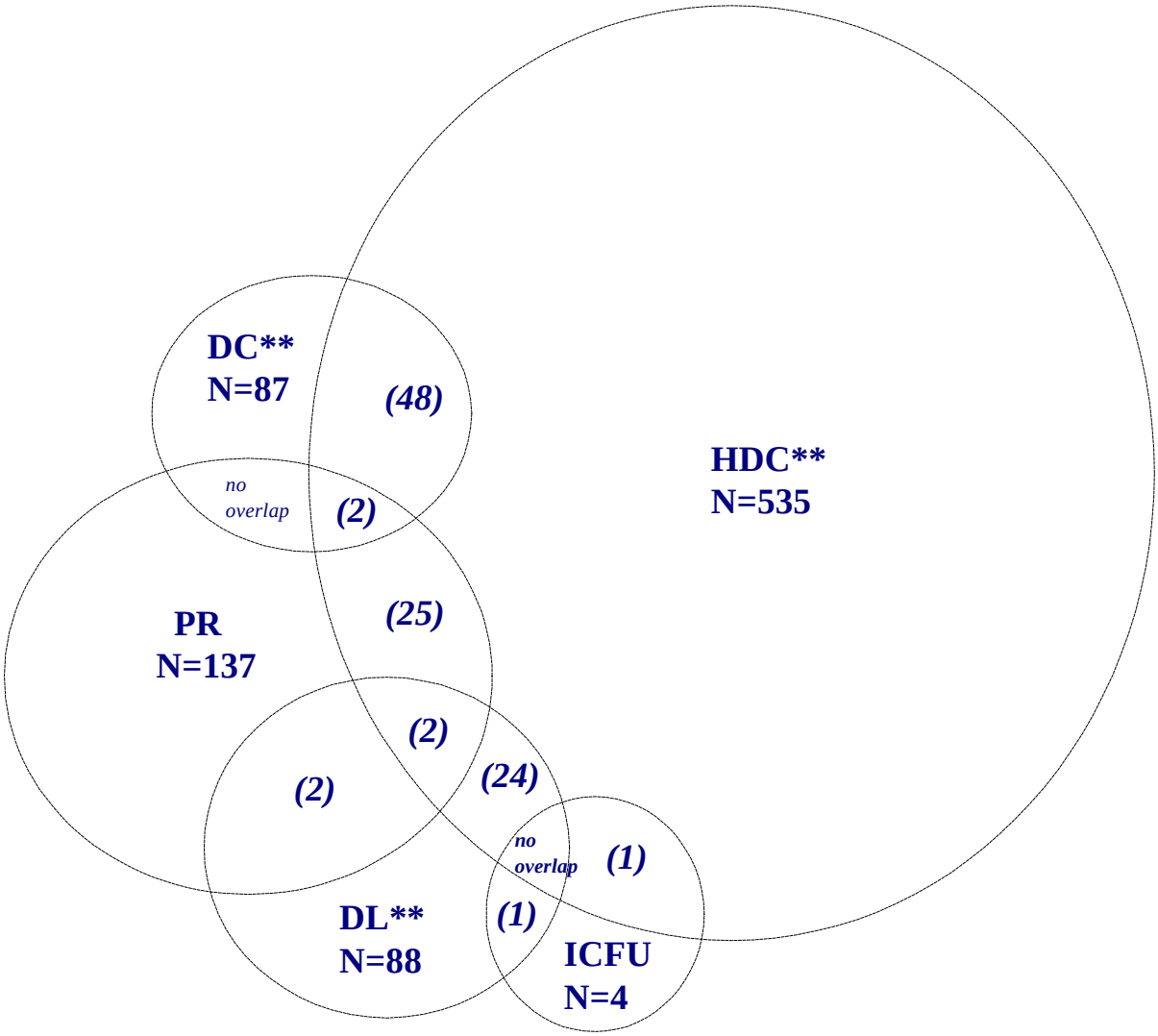
Figure 1. Number of Individuals Confirmed with Silicosis by Year Reported*



*** Total number of individuals: 706.**

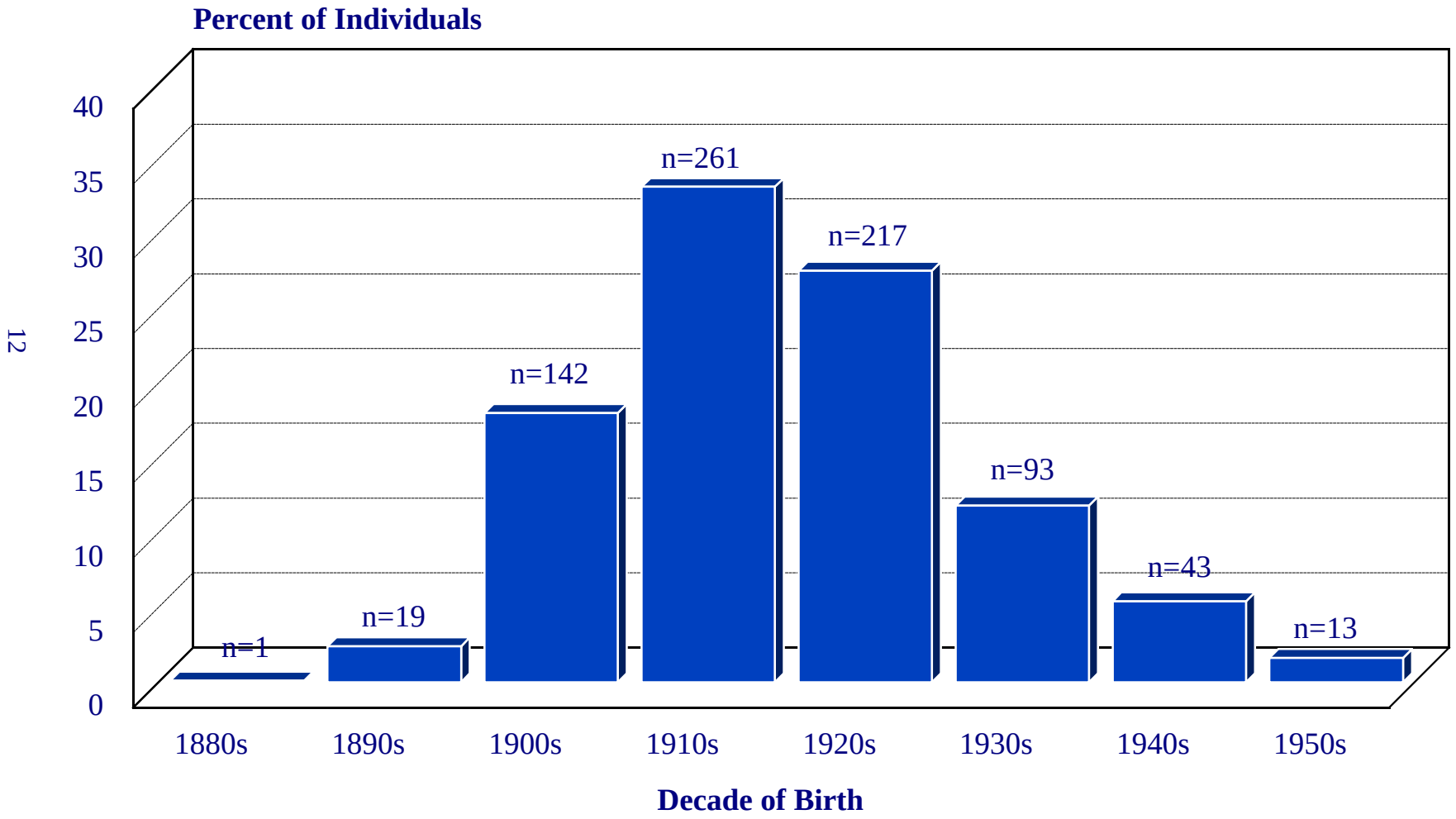
Figure 2. Overlap of Reporting Sources for Confirmed Individuals with Silicosis: 1987-1998*



* Diagram represents 727 individuals initially reported from 1987-1998.
Numbers in parentheses represent the overlap of reporting sources.
HDC=Hospital Discharge Data; DC=Death Certificate; PR=Physician Referral;
DL=Department of Labor; ICFU=Index Case Follow-Up.
N's represent the total number for that source.

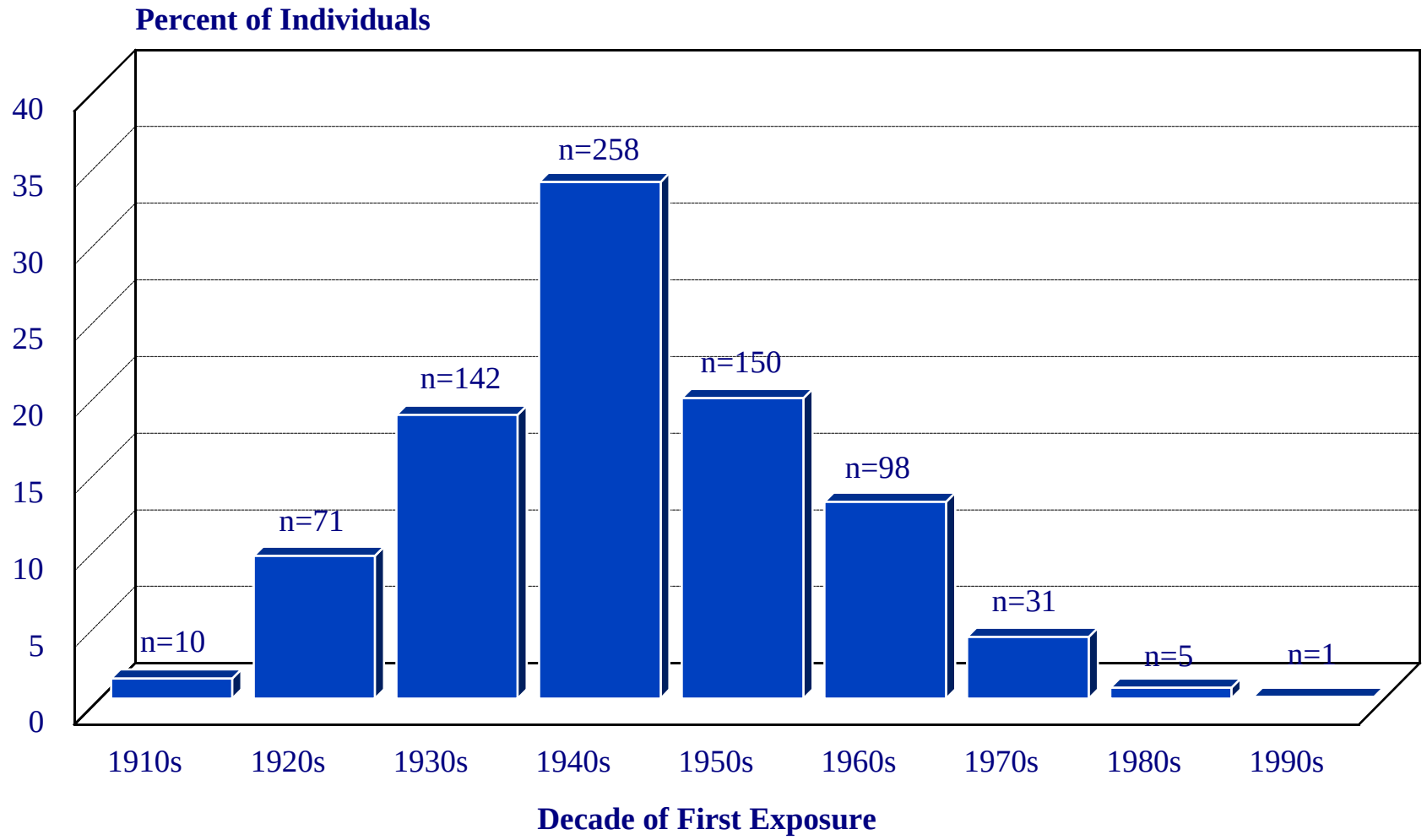
**There was also an overlap of HDC-DC-DL for six individuals, and an overlap of HDC-PR-DL-DC for one individual.

Figure 3. Distribution of Decade of Birth for Individuals Confirmed with Silicosis: 1985-1999*



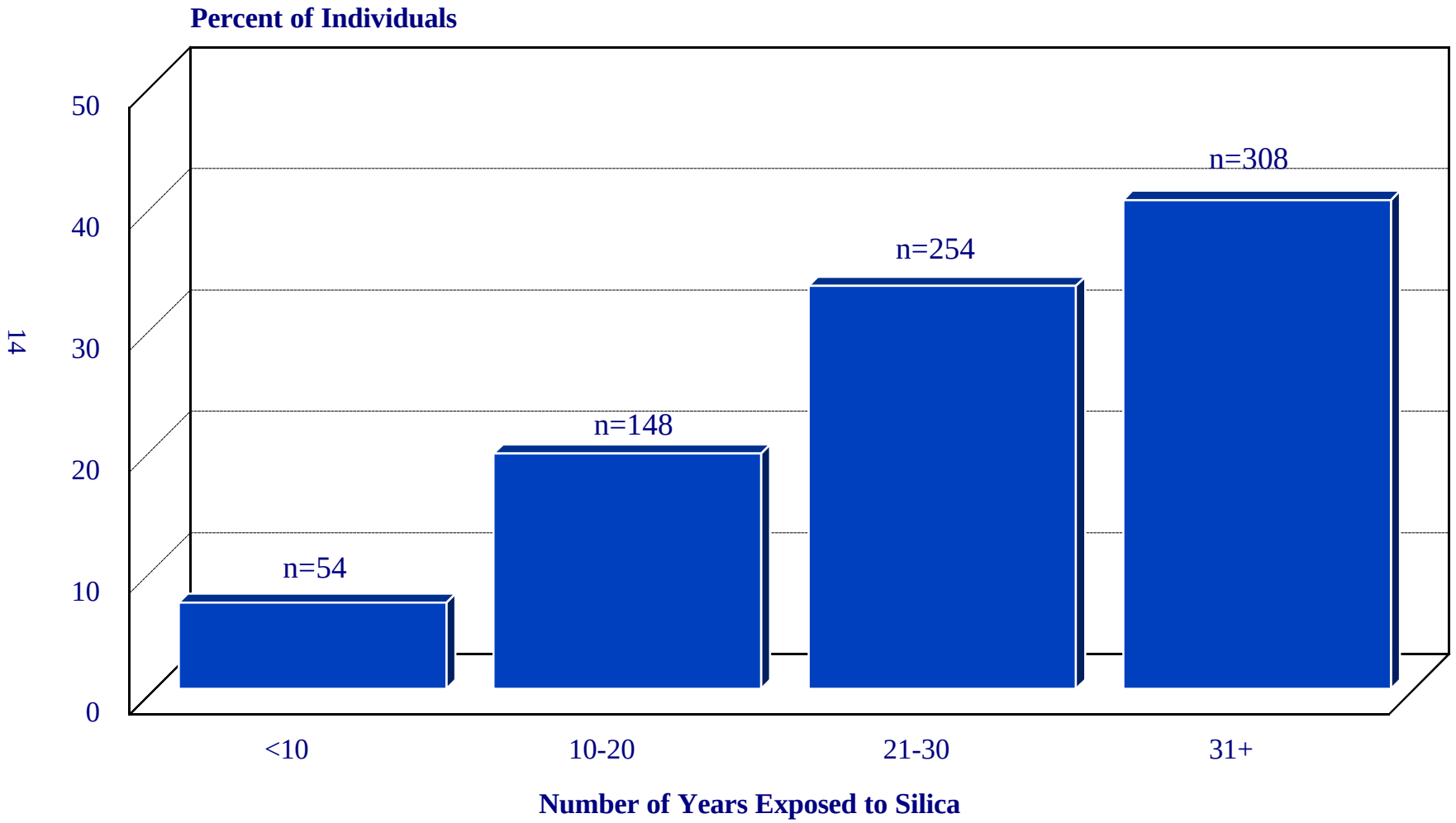
* Total number of individuals: 789.

Figure 4. Distribution of Decade When Silica Exposure Began for Individuals Confirmed with Silicosis: 1985-1999*



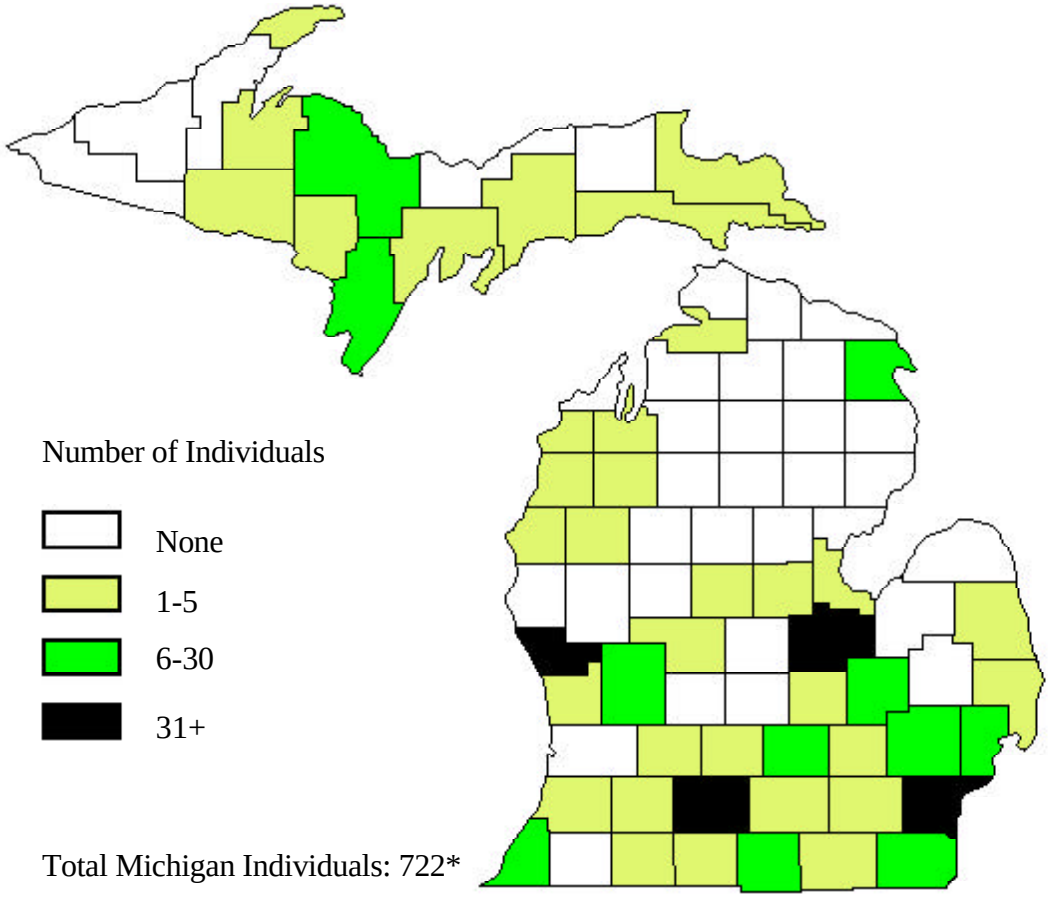
* Total number of individuals: 766. Unknown decade for 23 individuals.

Figure 5. Distribution of Years Worked at a Silica Exposed Job for Individuals Confirmed with Silicosis: 1985-1999*



* Total number of individuals: 764. Unknown decade for 25 individuals.

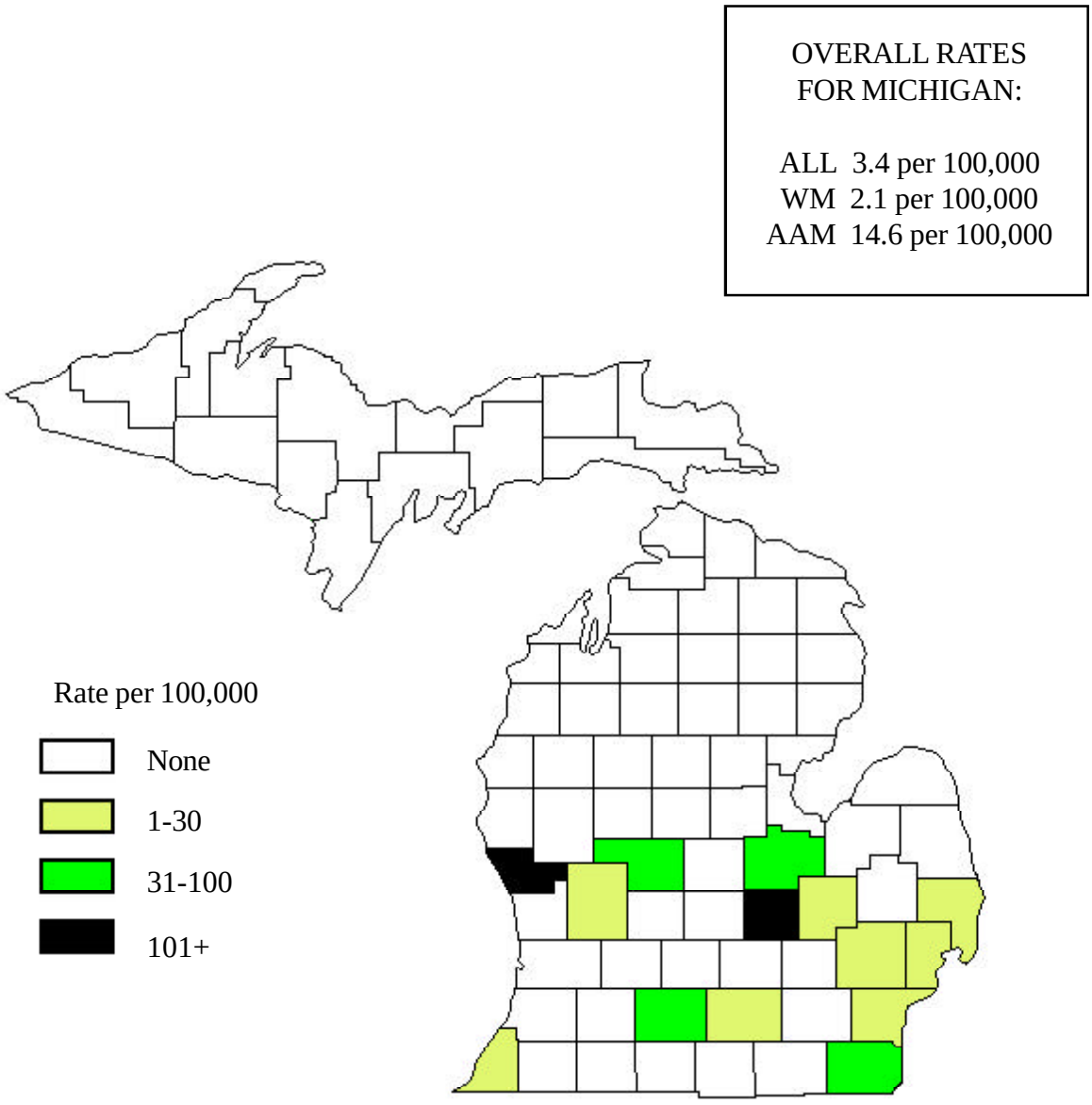
Figure 6. Distribution of Confirmed Silicosis Individuals by County of Exposure: 1985-1999



Muskegon, Saginaw and **Wayne** counties had the highest number of silicosis individuals, with 187, 122 and 200 individuals, respectively.

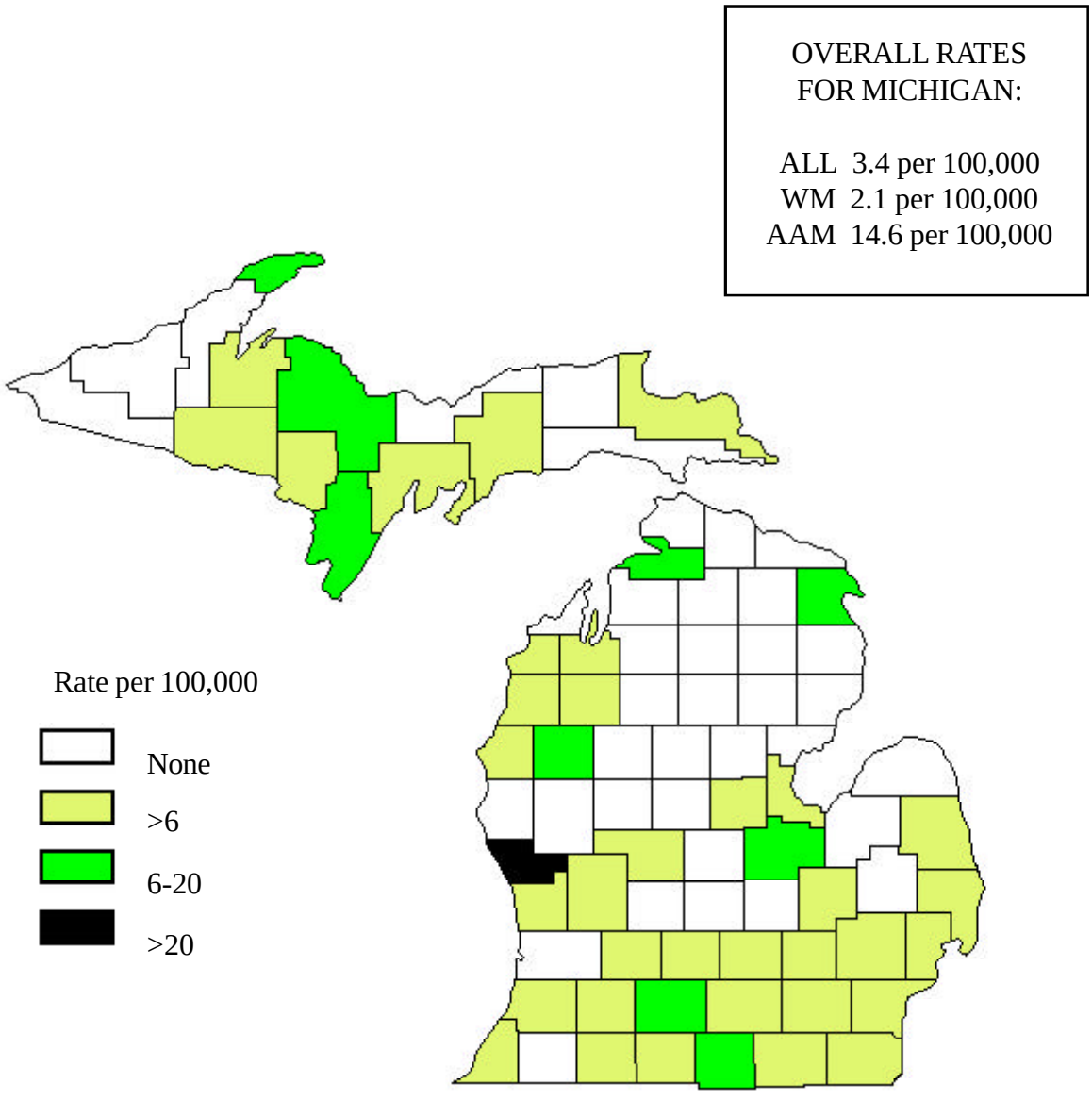
*Sixty-one individuals were exposed to silica out-of-state, and six individuals had an unknown county of exposure.

Figure 7. Average Annual Incidence Rate of Silicosis Among African American Males by County of Exposure: 1987-1997*



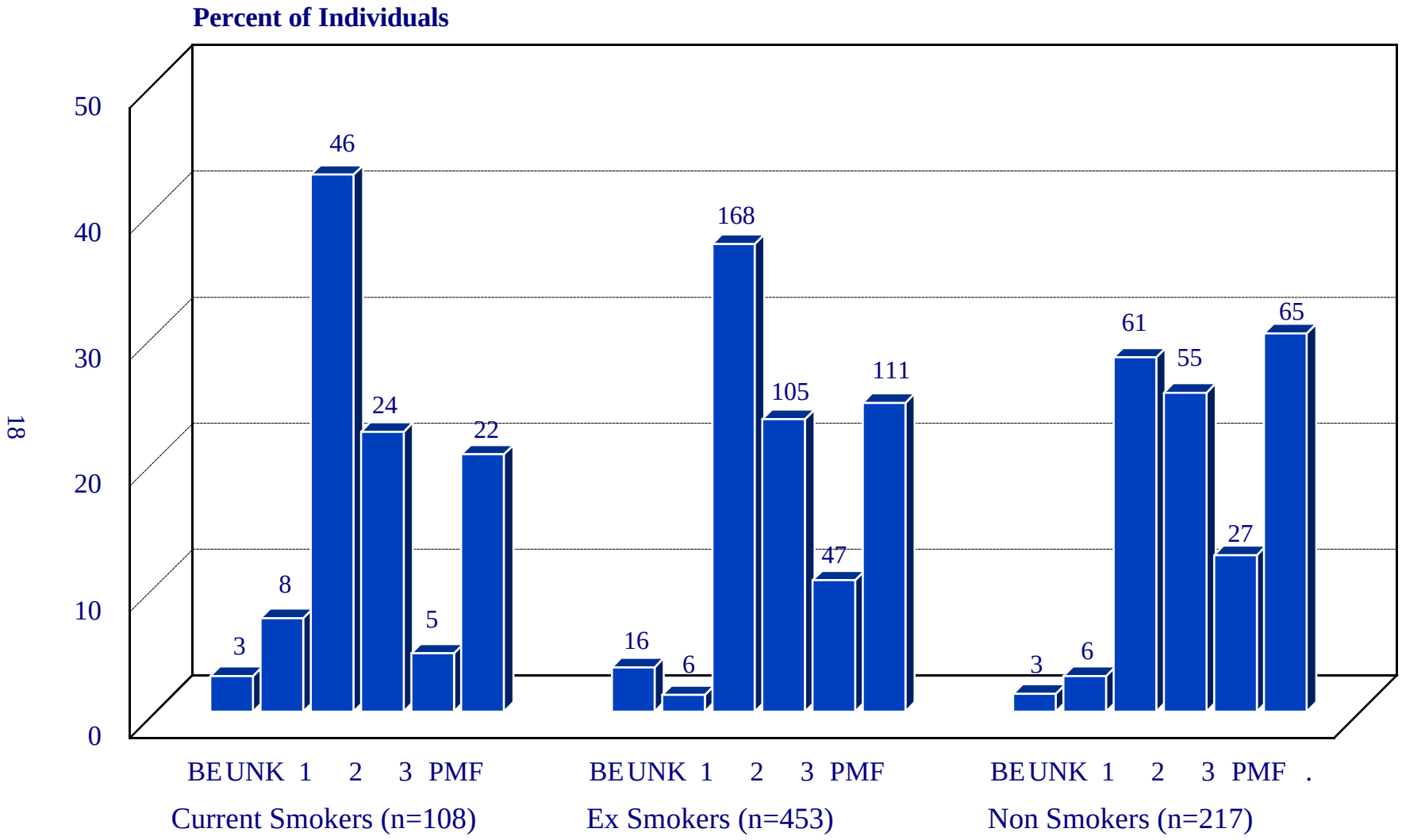
*Rate per 100,000 among African American men age 40+. Numerator is the average number of individuals for the years 1987-1997; denominator is the 1990 U.S. Census population data for African American men age 40 and older, by county. In 1990, there were 174,325 African American males 40 years and older living in Michigan.

Figure 8. Average Annual Incidence Rate of Silicosis Among White Males by County of Exposure: 1987-1997*



*Rate per 100,000 among white men age 40+. Numerator is the average number of individuals for the years 1987-1997; denominator is the 1990 U.S. Census population data for white men age 40 and older, by county. In 1990, there were 1,410,341 white males 40 years and older living in Michigan.

Figure 9. Severity of X-Ray Results* by Smoking Status for Individuals** Confirmed with Silicosis: 1985-1999



* BE=Biopsy Evidence; UNK=Unknown; 1-3=International Labor Organization categorization system for grading pneumoconioses; Category 1=1/0, 1/1, 1/2; Category 2=2/1, 2/2, 2/3; Category 3=3/2, 3/3, 3/+; PMF=Progressive Massive Fibrosis.

** Total number of individuals: 778. Unknown smoking status for 11 individuals.

Table 1. Number of Confirmed Individuals with Silicosis by Year and Reporting Source*

	PR	HDC	DC	DL	ICFU	Total
<1988	--	68	34	42	–	144
1988	–	57	5	7	–	69
1989	7	41	8	4	3	63
1990	5	44	0	6	1	56
1991	5	36	1	6	0	48
1992	16	54	6	2	0	78
1993	6	31	1	4	0	42
1994	7	36	1	28	0	72
1995	27	35	3	1	0	66
1996	28	35	0	0	0	63
1997	13	48	1	0	0	62
1998	9	11	1	0	0	21
1999	4	–	–	1	–	5
All Years	127	496	61	101	4	789

*PR=physician referral; HDC=hospital discharge data; DC=death certificate; DL=department of labor; ICFU=index case follow up.

Table 2. Primary Industry Where Silica Exposure Occurred for Individuals Confirmed with Silicosis for the Years 1985-1999

Industry (SIC code)*	Number of Individuals**	
Manufacturing		
Primary Metal Industries (33)	617	(78.6)
Includes iron, steel, gray & ductile iron foundries.		
Stone, Clay, Glass and Concrete Products (32)	38	(4.8)
Transportation Equipment (37)	30	(3.8)
Includes auto bodies and boat building		
Fabricated Metal Products (34)	10	(1.3)
Industrial Machinery (35)	8	(1.0)
Miscellaneous (25,26,28,30,36,39)	13	(1.7)
Includes chemicals and allied products, rubber parts, metalworking machinery and dental equipment.		
Mining (10-14)	20	(2.5)
Construction (15-17)	39	(5.0)
Transportation, Communication, etc. Services (40-49)	5	(0.6)
Wholesale Trade (50)	1	(0.1)
Business and Repair Services (73,76)	2	(0.3)
Dental Laboratory (80)	2	(0.3)
Total	785	(100.0)

*Standard Industrial Classification

**For four workers, the industrial classification was not known. Percentages are in parentheses.

Table 3. Percent Predicted Forced Vital Capacity (FVC) by X-Ray Results and Cigarette Smoking Status for Individuals* Confirmed with Silicosis for the Years 1985-1999

Percent FVC**

	<60%		60-79%		>80%	
X-Ray Results	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked
Biopsy Evidence	5 (31.3)	0 --	8 (50.0)	1 (33.3)	3 (18.8)	2 (66.7)
Unknown Severity	3 (27.3)	1 (33.3)	4 (36.4)	1 (33.3)	4 (36.4)	1 (33.3)
Category 1	38 (23.9)	14 (31.8)	55 (34.6)	11 (25.0)	66 (41.5)	19 (43.2)
Category 2	28 (30.4)	16 (41.0)	29 (31.5)	11 (28.2)	35 (38.0)	12 (30.8)
Category 3	9 (28.1)	12 (66.7)	13 (40.6)	3 (16.7)	10 (31.3)	3 (16.7)
PMF	31 (35.2)	14 (33.3)	31 (35.2)	15 (35.7)	26 (29.5)	13 (31.0)
Total	114 (28.6)	57 (38.3)	140 (35.2)	42 (28.2)	144 (36.2)	50 (33.6)

* Total number of individuals: 547. Information was missing for 242 individuals.

**Number, percentage in parentheses. Percentages represent the proportion of individuals in each of the x-ray result categories, within smoking status category (ever or never).

Table 4. Ratio of Forced Expiratory Volume in 1 Second (FEV_1) Divided by Forced Vital Capacity (FVC) by X-ray Results and Cigarette Smoking Status for Individuals* Confirmed with Silicosis for the Years 1985-1999

FEV_1/FVC**

	<40 %		41%-59%		60-74%		>75%	
X-Ray Results	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked
Biopsy Evidence	2 (12.5)	1 (33.3)	3 (18.8)	0 (–)	5 (31.3)	2 (66.7)	6 (37.5)	0 (–)
Unknown Severity	0 (–)	0 (–)	0 (–)	0 (–)	1 (12.5)	2 (66.7)	7 (87.5)	1 (33.3)
Category 1	16 (10.1)	2 (4.5)	33 (20.9)	3 (6.8)	59 (37.3)	13 (29.5)	50 (31.6)	26 (59.1)
Category 2	3 (3.4)	2 (5.1)	18 (20.7)	5 (12.8)	37 (42.5)	11 (28.2)	29 (33.3)	21 (53.8)
Category 3	1 (3.2)	1 (5.6)	5 (16.1)	0 (–)	5 (16.1)	5 (27.8)	20 (64.5)	12 (66.7)
PMF	13 (15.3)	4 (9.5)	24 (28.2)	9 (21.4)	27 (31.8)	13 (31.0)	21 (24.7)	16 (38.1)
Total	35 (9.1)	10 (6.7)	83 (21.6)	17 (11.4)	134 (34.8)	46 (30.9)	133 (34.5)	76 (51.0)

* Total number of individuals: 534. Information was missing for 255 individuals.
**Number, percentage in parentheses. Percentages represent the proportion of individuals in each of the x-ray result categories, within smoking status category (ever or never).

Table 5. Medical Conditions Associated with Exposure to Silica

Non-Malignant	Malignant
Alveolar Proteinosis (Acute Silicosis)	Lung Cancer
Parenchymal Fibrosis (Silicosis)	
Tuberculosis	
Connective Tissue Disease	
Chronic Renal Failure	
Emphysema	

Table 6. Status of Facilities Where 789 Individuals Confirmed with Silicosis for the Years 1985-1999 were Exposed to Silica

	Number of Individuals Represented	Number of Facilities	Percent of Facilities
Inspections	363	69	(23.7)
Closed	302	104	(35.7)
Out of State	50	46	(15.8)
Scheduled for Inspections	4	4	(1.4)
No Longer Use Silica	22	20	(6.9)
Unknown	20	20	(6.9)
Building Trade	27	27	(9.3)
Inspected by MSHA	1	1	(0.3)
Total	789	291	100.0

Table 7. Results of Industrial Hygiene Inspections of 69 Facilities Where Individuals Confirmed with Silicosis for the Years 1985-1999 were Exposed to Silica

		Number of Companies	Percent
Air Sampling Performed	49		
Above NIOSH Recommended Standard for Silica		31	(63.3)
Above MIOSHA Enforceable Standard for Any Exposure		21	(42.9)
Above MIOSHA Enforceable Standard for Silica		21	(42.9)
Medical Surveillance Evaluated	60		
Periodic Chest Xrays with B Reader		6	(10.0)
Periodic Chest Xrays without a B Reader		2	(3.3)
Pre-employment Testing Only		19	(31.7)
No Medical Surveillance		22	(36.7)
Periodic Pulmonary Function Testing		15	(25.0)