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Surveillance for Smoking-Attributable Mortality and Years of Potential Life Lost, by State — United States, 1990

Surveillance for Occupational Asthma — Michigan and New Jersey, 1988–1992

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Objectives of Injury Control, National	NCEHIC	1988; Vol. 37, No. SS-1

*Abbreviations

NCCDPHP	National Center for Chronic Disease Prevention and Health Promotion
NCEH	National Center for Environmental Health
NCEHIC	National Center for Environmental Health and Injury Control
NCID	National Center for Infectious Diseases
NCIPC	National Center for Injury Prevention and Control
CIO	Centers/Institute/Offices
NCPS	National Center for Prevention Services
IHPO	International Health Program Office
EPO	Epidemiology Program Office
NIOSH	National Institute for Occupational Safety and Health

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Lead Poisoning, Childhood	NCEHIC	1990; Vol. 39, No. SS-4
Low Birth Weight	NCCDPHP	1990; Vol. 39, No. SS-3
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Malformations (see also Birth Defects)	NCEHIC	1985; Vol. 34, No. 2SS
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Measles	NCPS	1992; Vol. 41, No. SS-6
Meningococcal Disease	NCID	1993; Vol. 42, No. SS-2
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National Infant Mortality (see also Infant Mortality; Birth Defects)	NCCDPHP	1989; Vol. 38, No. SS-3
Neisseria gonorrhoeae, Antimicrobial Resistance in	NCPS	1993; Vol. 42, No. SS-3
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State Activities	NIOSH	1987; Vol. 36, No. SS-2
Treated in Hospital Emergency Rooms	NIOSH	1983; Vol. 32, No. 2SS
Ovarian Cancer (see Endometrial & Ovarian Cancers)	EPO, NCCDPHP	1986; Vol. 35, No. 2SS
Parasites, Intestinal	NCID	1991; Vol. 40, No. SS-4
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Pelvic Inflammatory Disease	NCPS	1983; Vol. 32, No. 4SS
Pertussis	NCPS	1992; Vol. 41, No. SS-8
Plague	NCID	1985; Vol. 34, No. 2SS
Plague, American Indians	NCID	1988; Vol. 37, No. SS-3
Pneumoconiosis, Coal Miners	NIOSH	1983; Vol. 32, No. 1SS
Poliomyelitis	NCPS	1992; Vol. 41, No. SS-1
Postneonatal Mortality	NCCDPHP	1991; Vol. 40, No. SS-2
Pregnancy Nutrition	NCCDPHP	1992; Vol. 41, No. SS-7
Pregnancy, Teenage	NCCDPHP	1993; Vol. 42, No. SS-6
Psittacosis	NCID	1983; Vol. 32, No. 1SS
Rabies	NCID	1989; Vol. 38, No. SS-1
Racial/Ethnic Minority Groups	Various	1990; Vol. 39, No. SS-3
Respiratory Disease	NCEHIC	1992; Vol. 41, No. SS-4
Reye Syndrome	NCID	1984; Vol. 33, No. 3SS
Rocky Mountain Spotted Fever	NCID	1984; Vol. 33, No. 3SS
Rotavirus	NCID	1992; Vol. 41, No. SS-3
Rubella & Congenital Rubella	NCPS	1984; Vol. 33, No. 4SS
Salmonella	NCID	1988; Vol. 37, No. SS-2
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Smoking-Attributable Mortality	NCCDPHP	1994; Vol. 43, No. SS-1
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Sudden Unexplained Death Syndrome Among Southeast Asian Refugees	NCEHIC, NCPS	1987; Vol. 36, No. 1SS
Suicides, Persons 15–24 Years of Age	NCEHIC	1988; Vol. 37, No. SS-1
Summer Mortality	NCEHIC	1983; Vol. 32, No. 1SS
Syphilis, Congenital	NCPS	1993; Vol. 42, No. SS-6
Syphilis, Primary & Secondary	NCPS	1993; Vol. 42, No. SS-3
Tetanus	NCPS	1992; Vol. 41, No. SS-8
Toxic-Shock Syndrome	NCID	1984; Vol. 33, No. 3SS
Trichinosis	NCID	1991; Vol. 40, No. SS-3
Tubal Sterilization Among Women	NCCDPHP	1983; Vol. 32, No. 3SS
Tuberculosis	NCPS	1991; Vol. 40, No. SS-3
Waterborne Disease Outbreaks	NCID	1993; Vol. 42, No. SS-5
Years of Potential Life Lost	EPO	1992; Vol. 41, No. SS-6

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Surveillance for Smoking-Attributable Mortality and Years of Potential Life Lost, by State — United States, 1990

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Abstract

Problem/Condition: Mortality and years of potential life lost attributable to cigarette smoking.
Reporting Period Covered: 1990.
Description of System: Mortality and years of potential life lost were estimated for each state by using the Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) software. These estimates were based on attributable risk formulas for smoking-related causes of death. Estimates of smoking prevalence were obtained from the Behavioral Risk Factor Surveillance System and the U.S. Bureau of the Census, and mortality data were obtained from CDC.
Results: The median estimate for the number of smoking-attributable deaths among states was 5,619 (range: 402 [Alaska] to 42,574 [California]). Within each state, the number of smoking-attributable deaths among males was approximately twice as high as among females. Utah had the lowest mortality rate (218.0 per 100,000 population) and the lowest percentage of all deaths attributable to cigarette smoking (13.4%). Nevada had the highest mortality rate (478.1 per 100,000 population) and the highest percentage of deaths from smoking (24.0%). The number of years of potential life lost ranged from 6,720 (Alaska) to 498,297 (California).
Interpretation: The number of deaths attributable to cigarette smoking in 1990 remained high. Efforts are needed to control tobacco use in all states.
Actions Taken: SAMMEC data are used in many states to assist policymakers in strengthening tobacco control efforts.

INTRODUCTION

Cigarette smoking is the single most preventable cause of premature death in the United States (*1*). In 1990, smoking accounted for more than 400,000 deaths nationwide (*2*). Although national estimates of smoking-attributable mortality (SAM) and years of potential life lost (YPLL) have been made periodically (*1–11*), state-specific SAM and YPLL estimates for all states have been published only for 1985 (*12,13*).

SAM and YPLL data can be used by states to document the toll of smoking-related health problems and to encourage tobacco control efforts in a variety of settings (*14–18*).

METHODS

For this report, state-specific cigarette smoking prevalence, SAM, and YPLL from smoking were estimated by using the Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) software package (version 2.1) (*19*) developed by CDC's Office on Smoking and Health. SAMMEC estimates the number of smoking-related deaths from neoplastic, cardiovascular, and respiratory conditions and diseases of infants by using attributable risk formulas based on smoking prevalence and relative risks for certain conditions among current and former smokers (compared with risks for nonsmokers) (Table 1). Injury surveillance studies are used to estimate burn deaths associated with cigarette smoking (*19*) (Table 1).

State estimates of cigarette smoking prevalence in 1990 were obtained from the Behavioral Risk Factor Surveillance System (BRFSS) for 44 states and the District of Columbia. For the six states not participating in BRFSS in 1990 (Alaska, Arkansas, Kansas, Nevada, New Jersey, and Wyoming), prevalence estimates were obtained from the 1989 Current Population Survey conducted by the U.S. Bureau of the Census (U.S. Bureau of the Census, unpublished data, 1990). Mortality data for 1990 were obtained from CDC's National Center for Health Statistics (NCHS). To estimate deaths among infants (i.e., deaths among children <1 year of age), the 1989 national estimate of cigarette smoking prevalence of 20% among pregnant women was used for all states (*20*). SAM rates per 100,000 were calculated for persons ≥35 years of age* and were age-adjusted to the 1990 U.S. population to provide comparable estimates across states. YPLL that accounts for life expectancy at age of death was calculated by using standard methodology (*19*).

RESULTS

State-specific estimates of cigarette smoking prevalence among persons ages 35–64 years ranged from 21.8% to 39.7% for men and from 14.6% to 30.8% for women (Table 2). For persons ≥65 years of age, the prevalence ranged from 9.1% to 26.0% for men and from 4.7% to 19.1% for women.

The median estimate for the number of smoking-attributable deaths was 5,619 (range: from 402 [Alaska] to 42,574 [California]) (Table 3). Within each state, males had approximately twice as many smoking-attributable deaths as females. When the data were totaled across all states, 415,226 deaths were attributable to smoking. The median SAM rate was 363.3 per 100,000 population; this rate ranged from 218.0 per 100,000 in Utah to 478.1 per 100,000 in Nevada. The median percentage of all deaths attributable to smoking was 19.2% (range: from 13.4% [Utah] to 24.0% [Nevada]). The median estimate for YPLL was 66,959 (range: from 6,720 [Alaska] to 498,297 [California]) (Table 4).

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*In categories other than deaths from burns and deaths among infants, the number of deaths among persons <35 years of age was too small to attain statistical significance.

DISCUSSION

These findings indicate that, in 1990, cigarette smoking contributed substantially to premature mortality. SAM rates tended to be higher in the southeastern states, but all states continued to report substantial numbers of premature deaths caused by cigarette use. Although different data sources were used for cigarette smoking prevalence and state-specific estimates of deaths from environmental tobacco smoke were lacking, the total of 415,226 deaths totaled across the states is similar to the recent 1990 national estimate of 418,690 deaths from smoking (*2*). If the state-based estimate were augmented by the 3,000 deaths from environmental tobacco smoke that were included in the national estimate, the two estimates would differ by <1%.

State SAMMEC estimates have been published in health journals and state reports to notify scientists, policymakers, and the public of the magnitude of mortality

TABLE 1. Relative risks attributable to smoking and estimated smoking-attributable mortality (SAM) for current and former smokers compared with nonsmokers, by disease category and sex — United States, 1990

	Relative risk			
	Males		Females	
Disease category (ICD-9)	Current smokers	Former smokers	Current smokers	Former smokers
Diseases among adults (≥35 yrs of age)				
Neoplasms				
Lip, oral cavity, pharynx (140–149)	27.5	8.8	5.6	2.9
Esophagus (150)	7.6	5.8	10.3	3.2
Pancreas (157)	2.1	1.1	2.3	1.8
Larynx (161)	10.5	5.2	17.8	11.9
Trachea, lung, bronchus (162)	22.4	9.4	11.9	4.7
Cervix uteri (180)	NA	NA	2.1	1.9
Urinary bladder (188)	2.9	1.9	2.6	1.9
Kidney, other urinary (189)	3.0	2.0	1.4	1.2
Cardiovascular diseases				
Hypertensive diseases (401–404)	1.9	1.3	1.7	1.2
Ischemic heart disease (410–414)				
Persons ages 35–64 yrs	2.8	1.8	3.0	1.4
Persons ages ≥65 yrs	1.6	1.3	1.6	1.3
Other heart diseases (390–398, 415–417, 420–429)	1.9	1.3	1.7	1.2
Cerebrovascular diseases (430–438)				
Persons ages 35–64 yrs	3.7	1.4	4.8	1.4
Persons ages ≥65 yrs	1.9	1.3	1.5	1.0
Atherosclerosis (440)	4.1	2.3	3.0	1.3
Aortic aneurysm (441)	4.1	2.3	3.0	1.3
Other arterial diseases (442–448)	4.1	2.3	3.0	1.3
Respiratory diseases				
Pneumonia and influenza (480–487)	2.0	1.6	2.2	1.4
Bronchitis and emphysema (491–492)	9.7	8.8	10.5	7.0
Chronic airways obstruction (496)	9.7	8.8	10.5	7.0
Other respiratory diseases (010–012, 493)	2.0	1.6	2.2	1.4
Diseases among infants (<1 yr of age)				
Short gestation, low birth weight (765)	1.8		1.8	
Respiratory distress syndrome (769)	1.8		1.8	
Other respiratory conditions of newborn (770)	1.8		1.8	
Sudden infant death syndrome (798)	1.5		1.5	
Deaths* from burns (E890–E899)	NA		NA	

*Estimated to be 50% of deaths on the basis of injury surveillance studies (*19*).
NA = not applicable.
ICD-9 = *International Classification of Diseases*, 9th revision.

TABLE 2. State-specific estimates of cigarette smoking prevalence, by age and sex — United States, 1990

	Age (yrs)			
	35–64		≥65	
State	**Men (%)**	**Women (%)**	**Men (%)**	**Women (%)**
Alabama	31.1	22.9	15.0	6.2
Alaska	33.3	24.5	17.8	13.2
Arizona	24.0	21.0	11.0	10.1
Arkansas	35.9	29.8	16.4	6.7
California	21.8	21.7	16.8	16.6
Colorado	24.2	26.4	12.5	11.4
Connecticut	27.4	22.9	11.8	12.0
Delaware	23.7	28.0	11.3	8.4
District of Columbia	30.4	21.0	21.2	6.8
Florida	33.7	21.6	17.4	13.1
Georgia	34.8	25.9	19.4	13.0
Hawaii	26.5	20.4	12.1	7.5
Idaho	23.7	20.8	12.5	11.8
Illinois	34.0	23.9	17.0	17.7
Indiana	33.1	26.4	16.8	11.7
Iowa	28.2	22.0	12.1	8.4
Kansas	30.7	18.7	14.2	6.7
Kentucky	39.7	29.0	19.1	11.3
Louisiana	32.7	24.7	14.9	8.6
Maine	33.2	24.3	17.0	12.7
Maryland	27.5	20.6	15.2	13.5
Massachusetts	28.2	20.1	16.5	15.3
Michigan	34.1	28.2	17.2	11.7
Minnesota	24.6	23.1	12.3	7.9
Mississippi	33.3	21.3	20.8	11.3
Missouri	31.9	23.6	14.9	11.2
Montana	25.2	25.1	12.2	15.6
Nebraska	33.3	25.5	20.9	7.9
Nevada	38.4	30.1	15.0	12.1
New Hampshire	25.2	21.5	16.3	14.5
New Jersey	28.8	25.1	13.0	15.1
New Mexico	22.8	25.1	15.7	11.7
New York	23.1	30.2	10.6	12.6
North Carolina	31.2	29.3	20.6	9.5
North Dakota	26.5	26.5	11.8	4.7
Ohio	30.3	27.7	9.1	12.9
Oklahoma	30.5	30.8	19.5	12.2
Oregon	27.7	22.1	11.3	13.7
Pennsylvania	27.7	25.1	10.8	13.3
Rhode Island	28.5	26.4	18.5	10.3
South Carolina	39.4	24.8	26.0	13.6
South Dakota	25.8	21.8	18.3	9.9
Tennessee	33.0	28.4	25.1	12.1
Texas	27.0	25.9	18.3	14.9
Utah	25.2	14.6	10.8	7.3
Vermont	26.1	20.9	11.3	10.0
Virginia	28.7	24.7	16.3	14.4
Washington	26.7	19.9	15.7	15.5
West Virginia	32.7	26.2	18.3	16.4
Wisconsin	28.1	26.4	10.0	9.7
Wyoming	28.2	27.6	20.1	19.1
Highest value	**39.7**	**30.8**	**26.0**	**19.1**
Lowest value	**21.8**	**14.6**	**9.1**	**4.7**
Median	**28.5**	**24.7**	**15.7**	**11.8**

Source: 1990 Behavioral Risk Factor Surveillance System for 44 states and the District of Columbia; 1989 Current Population Survey of the U.S. Bureau of the Census for Alaska, Arkansas, Kansas, Nevada, New Jersey, and Wyoming.

TABLE 3. State-specific estimates of smoking-attributable mortality, by sex — United States, 1990

State	Male	Female	Total	Rate*	Rank†	Percentage of all deaths
Alabama	4,960	1,841	6,801	350.4	22	17.3
Alaska	290	112	402	398.2	46	18.4
Arizona	3,839	1,858	5,697	339.6	16	19.8
Arkansas	3,410	1,296	4,706	376.3	35	19.1
California	25,821	16,753	42,574	366.3	27	19.9
Colorado	2,658	1,513	4,171	331.4	13	19.3
Connecticut	3,337	2,025	5,362	325.7	12	19.4
Delaware	745	433	1,178	393.1	44	20.4
District of Columbia	874	413	1,287	444.7	50	17.6
Florida	18,865	9,731	28,596	357.5	24	21.3
Georgia	6,692	3,002	9,694	383.5	38	18.7
Hawaii	849	325	1,174	257.2	2	17.3
Idaho	865	439	1,304	293.2	4	17.5
Illinois	12,028	7,241	19,269	360.0	25	18.7
Indiana	6,924	3,326	10,250	394.3	45	20.7
Iowa	3,410	1,406	4,816	304.2	7	17.9
Kansas	2,728	1,100	3,828	300.8	6	17.2
Kentucky	5,127	2,322	7,449	428.7	47	21.2
Louisiana	4,829	2,058	6,887	388.2	40	18.3
Maine	1,508	868	2,376	389.4	42	21.4
Maryland	4,593	2,777	7,370	378.1	36	19.2
Massachusetts	6,132	4,298	10,430	345.3	17	19.6
Michigan	10,386	5,068	15,454	372.5	33	19.6
Minnesota	4,237	1,890	6,127	295.2	5	17.6
Mississippi	3,188	1,270	4,458	375.1	34	17.7
Missouri	6,907	3,270	10,177	383.8	39	20.2
Montana	856	457	1,313	334.2	15	19.1
Nebraska	1,965	710	2,675	321.0	11	18.1
Nevada	1,517	717	2,234	478.1	51	24.0
New Hampshire	1,036	619	1,655	349.3	20	19.5
New Jersey	7,734	4,871	12,605	334.1	14	17.9
New Mexico	1,097	644	1,741	287.7	3	16.4
New York	18,612	12,380	30,992	352.8	23	18.3
North Carolina	7,922	3,110	11,032	367.6	30	19.2
North Dakota	790	241	1,031	308.2	9	18.2
Ohio	11,421	6,693	18,114	347.7	19	18.3
Oklahoma	4,132	2,006	6,138	390.4	43	20.2
Oregon	3,393	1,833	5,226	369.3	31	20.8
Pennsylvania	14,576	8,048	22,624	346.8	18	18.6
Rhode Island	1,250	631	1,881	350.3	21	19.6
South Carolina	3,928	1,691	5,619	380.1	37	18.9
South Dakota	877	298	1,175	307.9	8	18.6
Tennessee	7,146	3,068	10,214	442.1	49	22.1
Texas	16,705	8,747	25,452	389.1	41	20.3
Utah	940	288	1,228	218.0	1	13.4
Vermont	617	296	913	363.3	26	19.9
Virginia	5,926	3,311	9,237	366.6	28	19.2
Washington	4,892	2,898	7,790	367.4	29	21.0
West Virginia	2,831	1,390	4,221	433.6	48	21.8
Wisconsin	4,995	2,625	7,620	313.3	10	17.8
Wyoming	419	240	659	371.0	32	20.6
Highest value	**25,821**	**16,753**	**42,574**	**478.1**		**24.0**
Lowest value	**290**	**112**	**402**	**218.0**		**13.4**
Median	**3,839**	**1,841**	**5,619**	**363.3**		**19.2**

*Per 100,000 population among adults ages ≥35 years, age-adjusted to the 1990 U.S. population; rates exclude deaths among infants and burn deaths among persons ages 1–34 years.
†Based on mortality rate.

TABLE 4. Estimated smoking-attributable years of potential life lost,* by sex — United States, 1990

State	Years of potential life lost		
	Male	Female	Total
Alabama	62,287	28,073	90,360
Alaska	4,711	2,009	6,720
Arizona	42,421	24,538	66,959
Arkansas	39,425	19,317	58,742
California	290,416	207,881	498,297
Colorado	29,800	19,200	49,000
Connecticut	35,943	24,592	60,535
Delaware	9,102	6,146	15,248
District of Columbia	13,512	7,660	21,172
Florida	206,881	121,310	328,191
Georgia	88,396	45,772	134,168
Hawaii	10,135	5,087	15,222
Idaho	9,052	5,656	14,708
Illinois	143,258	92,675	235,933
Indiana	79,155	44,429	123,584
Iowa	34,121	16,400	50,521
Kansas	28,713	13,827	42,540
Kentucky	61,404	33,198	94,602
Louisiana	62,828	32,058	94,886
Maine	16,879	10,540	27,419
Maryland	55,786	36,411	92,197
Massachusetts	68,822	48,818	117,640
Michigan	123,337	72,263	195,600
Minnesota	44,365	23,470	67,835
Mississippi	39,230	18,609	57,839
Missouri	79,112	43,024	122,136
Montana	8,741	5,750	14,491
Nebraska	20,060	9,015	29,075
Nevada	19,291	10,963	30,254
New Hampshire	11,675	7,318	18,993
New Jersey	90,653	61,120	151,773
New Mexico	12,710	8,446	21,156
New York	219,751	157,779	377,530
North Carolina	99,223	48,587	147,810
North Dakota	8,028	3,689	11,717
Ohio	140,831	90,666	231,497
Oklahoma	46,252	26,805	73,057
Oregon	36,425	22,792	59,217
Pennsylvania	168,532	103,307	271,839
Rhode Island	14,006	7,535	21,541
South Carolina	52,910	26,159	79,069
South Dakota	9,033	3,651	12,684
Tennessee	87,627	45,008	132,635
Texas	201,112	116,519	317,631
Utah	10,552	4,020	14,572
Vermont	7,042	3,589	10,631
Virginia	74,535	45,181	119,716
Washington	53,757	35,465	89,222
West Virginia	32,784	18,223	51,007
Wisconsin	54,529	31,816	86,345
Wyoming	4,509	2,789	7,298
Highest value	**290,416**	**207,881**	**498,297**
Lowest value	**4,509**	**2,009**	**6,720**
Median	**42,421**	**24,538**	**66,959**

*Calculated by using life expectancy at age of death.

associated with smoking (*14–18,21*). For example, in Oregon, a report on tobacco use that relied heavily on SAMMEC calculations was used for assisting tobacco control efforts (*21*), and the state legislature enacted legislation to increase the state excise tax on cigarettes.

For at least three reasons, these estimates for SAM and YPLL are underestimated. First, these estimates were based on data for cigarette smoking prevalence from 1990. Most smoking-attributable deaths for that year resulted from smoking during preceding decades, when smoking prevalence was considerably higher (*10*). Second, the state-specific SAMMEC estimates do not include deaths from other conditions (e.g., such as environmental tobacco smoke [*22*], leukemia [*23*], and peptic ulcer disease [*1*]) that may also be associated with smoking, nor do they include mortality caused by other forms of tobacco use. Third, these data are not comparable with 1985 state-specific estimates because of substantial differences in SAMMEC methodology, in sources of data on state smoking prevalence, and in age adjustment of mortality rates (*12,13*).

To reduce the health impact of cigarette use, continued progress must be made in reducing smoking prevalence. Although smoking prevalence has declined substantially since the 1960s (*1*), about 20% of deaths in the United States can be attributed to cigarette smoking (*2*). Vigorous efforts are needed to prevent the initiation of smoking, encourage smoking cessation, and protect nonsmokers from the adverse effects of environmental tobacco smoke. Because many factors influence smoking initiation and smoking cessation, multiple approaches are necessary (*1*). Examples of these approaches include increasing educational efforts, reducing minors' access to tobacco products, increasing tobacco excise taxes, implementing more extensive and intensive counseling by health-care providers on smoking prevention and cessation, developing and enacting strong policies and laws for clean indoor air, and restricting or eliminating advertising to which persons <18 years old are likely to be exposed (*2,24*).

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Surveillance for Occupational Asthma — Michigan and New Jersey, 1988–1992

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Abstract

Problem/Condition: A case of occupational asthma is a sentinel health event indicating a need for preventive intervention.

Reporting Period Covered: 1988–1992.

Description of Systems: As part of the Sentinel Event Notification System for Occupational Risks (SENSOR) Program, initiated by CDC's National Institute for Occupational Safety and Health in 1987, state-based surveillance and intervention programs for occupational asthma (OA) have been under development in Michigan and New Jersey. The initial 5-year projects in these states have been completed.

Results: From 1988 through 1992, the SENSOR programs in these states identified a total of 535 cases of occupational asthma and related conditions. Of these 535 cases, 328 cases met the SENSOR surveillance case definition for OA. In addition, 128 cases were classified as possible OA, 42 as reactive airways dysfunction syndrome, and 37 as occupationally aggravated asthma. In both Michigan and New Jersey, manufacturing was the industrial sector with the largest proportion of cases. In Michigan, >40% of the case-patients worked in transportation equipment manufacturing. In New Jersey, 15% of case-patients worked in manufacturing of chemicals and allied products. Overall, isocyanates were the most frequently reported asthma-causing agents (19.4% of cases). Follow-up industrial hygiene sampling measured suspect agents at airborne concentrations generally below the permissible exposure limits established by the Occupational Safety and Health Administration.

Interpretation: In its first 5 years, the SENSOR system has led to the identification of previously unrecognized causes of occupational asthma. Overall findings indicate the need for more comprehensive control of such well-known occupational allergens as the isocyanates. In addition, SENSOR interventions have prompted improvements in protection for workers.

Actions Taken: Approaches to state-based surveillance and intervention for OA are being developed through newly funded 5-year SENSOR projects in four states (California, Massachusetts, Michigan, and New Jersey). The goal is to develop a model for effective state-based OA surveillance that can be applied by any state health department.

INTRODUCTION

In 1987, 10 states were awarded 5-year cooperative agreements with CDC's National Institute for Occupational Safety and Health to implement surveillance systems for selected occupational conditions under the Sentinel Event Notification System for Occupational Risks (SENSOR) Program (*1*). The Michigan Department of Public Health (MDPH), in cooperation with the College of Human Medicine at Michigan State University, and the New Jersey Department of Health (NJDOH) were each awarded SENSOR cooperative agreements for occupational asthma (OA) surveillance. This report summarizes OA surveillance data collected by the Michigan and New Jersey SENSOR programs for the period 1988–1992.

METHODS

Case Report Ascertainment

MDPH and NJDOH actively solicit occupational disease reports from physicians, hospitals, and clinics in their respective states. Active solicitation of occupational disease reports has been undertaken in the following ways: 1) potential cases are identified through a review of hospital discharge or death certificate date files, and follow-up is conducted to determine whether the medical condition was work related; 2) state SENSOR staff periodically conduct educational outreach to physicians who have a high likelihood of encountering patients with occupational asthma (e.g., allergists, pulmonologists, occupational medicine physicians, and members of the state thoracic society) in an effort to alert them to occupational disease reporting laws in their state, to encourage them to report cases, and to educate them about the objectives and activities of the SENSOR program; and 3) state SENSOR staff members develop and distribute occupational disease newsletters to physicians in an effort to provide them with up-to-date educational material on selected occupational conditions and to provide physicians with summary information about SENSOR surveillance and intervention activities.

In 1979, legislation that mandated clinical reporting of OA became effective in Michigan. New Jersey's legislation became effective in May 1990, although reports were received earlier through a voluntary reporting mechanism. In addition, some reports of OA have been ascertained through review of medical records of hospitalized patients discharged with a diagnosis coded as a respiratory condition resulting from inhalation of chemical fumes and vapors (*International Classification of Diseases*, 9th Revision [ICD-9] 506) (*2*). In both Michigan and New Jersey, hospitals are required to report all such discharge diagnoses to the state health departments.

The ICD-9 classification system does not contain a specific rubric for occupational asthma. Although the ICD-9 rubric 493 represents asthma, a substantial number of asthma cases are reported through hospital discharge records without being classified as work related (approximately 11,000 from Michigan and 15,000 from New Jersey annually). A study of all ICD-9 506 hospital discharge diagnoses reported directly to the NJDOH in 1985 and 1986 revealed that 39% were secondary to occupational exposures. A similar study of 1989 and 1990 hospital discharges in Michigan demonstrated that 35% of all hospital discharges coded to the ICD-9 506 rubric were work related (*3*). Of the 66 work-related code 506 diagnoses identified in the New Jersey study, 20% were classified as occupational asthma as documented by a follow-up review of the hospital medical records (*4*). As a result, searches for hospital discharges coded 506 are routinely undertaken in New Jersey and Michigan to identify potential cases of occupational asthma.

Case-patients reported to the SENSOR programs are interviewed by health department personnel to obtain demographic and exposure information (e.g., name of employer and location of exposure), and additional medical information. For some cases, information is also obtained from review of medical records, and, in New Jersey, some reported case-patients recorded serial lung function data by using portable peak-flow meters provided by the NJDOH.

Case Confirmation

Meeting the surveillance case definition for OA requires all three of the following criteria: a) a physician diagnosis of asthma, b) an association between symptoms of asthma and work (i.e., a particular job or process or work-related exposure), and c) exposure to an agent previously associated with asthma or evidence of an association between work exposure and either a significant decrease in lung function or increase in airways responsiveness (*5*). State SENSOR staff determine whether the available information for each reported case is sufficient to meet the case definition criteria.

Although not explicitly outlined in the published definition (*5*), if the asthmatic condition developed for the first time coincident with an acute exposure to an irritating chemical at work, the case is classified as reactive airways dysfunction syndrome (RADS) (*6*). If only criteria (a) and (b) of the published definition are met, the case is classified as possible OA. Finally, if a reported case of preexisting physician-diagnosed asthma became worse in association with a particular job (i.e., work-related exacerbation of symptom frequency or severity), the case is classified as occupationally aggravated asthma. The clinical signs and symptoms of occupational asthma and RADS are identical. However, RADS can occur after a single high-level exposure to an irritant gas, fume, smoke, or vapor. Onset of occupational asthma can occur after months or years of exposure to potential sensitizing agents.

Preventive Measures

To prevent OA in coworkers, SENSOR surveillance data have been used to target workplace investigations and interventions. Investigations of work sites have included industrial hygiene evaluations to identify suspected causative agents and to assess the facility's safety and health program. They may also include interviews with workers or reviews of company records to determine whether coworkers have been experiencing similar respiratory difficulties. On the basis of work site evaluations, recommendations are made to improve work conditions with respect to OA risk. In New Jersey, the evaluations have been conducted by industrial hygienists employed by the NJDOH. In Michigan, these evaluations are conducted by industrial hygienists from the Michigan Occupational Safety and Health Administration (MIOSHA) and may lead directly to issuance of citations for violations of health and safety codes.

SENSOR staff in Michigan and New Jersey mail educational materials about OA to identified case-patients, employers, and unions. SENSOR staff also prepare and distribute newsletters to physicians on SENSOR-related activities and findings. In addition, New Jersey and Michigan publish annual state reports summarizing data collected through SENSOR activities.

RESULTS

Epidemiology

From May 1988, the date of the initial solicitation* of physician reports, through December 1992, 230 reports were received by the NJDOH occupational asthma SENSOR program. Of the 230 reported cases, 106 (46.1%) met the surveillance case definition for OA, another 18 (7.8%) were possible OA, and 16 (7.0%) were RADS. An additional 14 (6.1%) were occupationally aggravated asthma (Table 1). The remaining 76 (33.0%) lacked evidence of either a clinical diagnosis of asthma or work-related asthma symptoms.

From January 1988 through December 1992, the MDPH received 538 reports of occupational asthma. Of these reports, 222 (41.3%) met the surveillance case definition for OA, another 110 (20.4%) were possible OA, and 26 (4.8%) were RADS. An additional 23 (4.3%) were occupationally aggravated asthma (Table 1). The remaining 157 (29.2%) lacked evidence of either a clinical diagnosis of asthma or work-related asthma symptoms. An additional 59 reports from that period are being confirmed and are not included in these data.

Physicians have provided the majority of case reports in both states. Reports from hospitals represented 20% of reports in Michigan and 6% of reports in New Jersey.

Manufacturing was the industrial sector with the greatest proportion of cases from both Michigan and New Jersey. Seventy-seven percent of case-patients reported in Michigan and 48% of case-patients reported in New Jersey were employed in some form of manufacturing. In Michigan, approximately 42% of the case-patients were employed specifically in the manufacture of transportation (e.g., automotive) equipment. In New Jersey, 15% of case-patients worked in manufacturing of chemical and allied products (Table 2).

A wide range of asthma-causing agents has been reported (Table 3). Isocyanates were the most frequently reported asthma inducers in both New Jersey and Michigan. Overall, isocyanates were associated with 19.4% of all cases. The next most frequently reported asthma-causing agents in Michigan were coolant /oil mists generated by machining operations (12.3%), aldehydes (including formaldehyde and glutaraldehyde) (3.7%), tungsten carbide/cobalt (3.7%), and epoxy resins (2.9%). In New Jersey, the

*The New Jersey SENSOR program conducted a mass mailing of information about the SENSOR program to approximately 1,200 physicians in the state.

TABLE 1. Number* of cases of occupational asthma and related conditions, by year reported — Michigan and New Jersey SENSOR programs, 1988–1992

	Occupational asthma			Possible occupational asthma			Reactive airways dysfunction syndrome			Occupationally aggravated asthma			Total		
Year	**MI**	**NJ**	**Both**	**MI**	**NJ**	**Both**	**MI**	**NJ**	**Both**	**MI**	**NJ**	**Both**	**MI**	**NJ**	**Both**
1988	22	20	42	6	1	7	1	0	1	0	1	1	29	22	51
1989	43	22	65	11	1	12	5	3	8	3	0	3	62	26	88
1990	75	23	98	30	5	35	8	9	17	8	3	11	121	40	161
1991	39	30	69	31	6	37	11	3	14	8	5	13	89	44	133
1992	43	11	54	32	5	37	1	1	2	4	5	9	80	22	102
Total	**222**	**106**	**328**	**110**	**18**	**128**	**26**	**16**	**42**	**23**	**14**	**37**	**381**	**154**	**535**

*Not included are 76 cases reported from New Jersey and 157 cases reported from Michigan for which evidence is lacking of either a clinical diagnosis of asthma or work-related asthma symptoms. Also excluded are an additional 59 cases from Michigan that are still being confirmed.

most frequently reported asthma-causing agents, following isocyanates, were aldehydes (9.1%), diesel exhaust (5.2%), pesticides/herbicides (5.2%), coolant /oil mists generated by machining operations (3.9%), and chlorine (3.9%).

Workplace Follow-up

In Michigan, 160 facilities were inspected. In 105 of these facilities, coworkers of the index case-patient were interviewed; 72 of these interviews identified 681 coworkers who had symptoms compatible with OA. Air sampling for agents known to induce occupational asthma was conducted at 109 facilities. At 93 (85.3%) of these facilities, levels measured at the time of inspection were below the legally enforceable permissible exposure limit (PEL) established by MIOSHA.

In New Jersey, industrial hygiene evaluations have been conducted at 42 workplaces. Air sampling for suspected asthma-causing agents was performed at 22 (52.3%) of the worksites. Measured levels were below the applicable PEL at 17 (77.3%) of these workplaces. Thirty-six (85.7%) of the 42 workplaces were found to have ineffective engineering controls, 33 (78.6%) had inadequate respiratory protection programs, and 36 (85.7%) did not have adequate air-monitoring programs. For each workplace inspected, the NJDOH sent a written report, with recommendations, to the employer, employee representative(s), union(s), reported case-patient(s), local health department, and reporting physician(s).

TABLE 2. Industries employing workers with reported cases of occupational asthma and related conditions — Michigan and New Jersey SENSOR programs, 1988–1992

	Michigan		New Jersey	
Industry (Standard Industrial Classification Code)	**No.**	**%**	**No.**	**%**
Manufacturing (20–39)	**292**	**76.8**	**74**	**48.1**
Transportation Equipment—includes automobiles, boats, yachts (37)	158	41.6	5	3.2
Chemicals and Allied Products (28)	24	6.3	23	14.9
Industrial and Commercial Machinery and Computer Equipment (35)	18	4.7	3	2.0
Rubber and Miscellaneous Plastic Products (30)	19	5.0	5	3.2
Fabricated Metal Products (34)	16	4.2	3	2.0
Primary Metal Industries—includes foundries (33)	14	3.7	4	2.6
Food and Kindred Products (20)	13	3.4	5	3.2
Stone, Clay, Glass, and Concrete Products (32)	3	0.8	5	3.2
Miscellaneous Manufacturing (22–27, 29, 31, 36, 38–39)	27	7.1	21	13.6
Transportation, Communications, Electric, Gas, & Sanitary Services (40, 42, 44, 47, 49)	**5**	**1.3**	**8**	**5.2**
Wholesale and Retail Trade (50, 51, 53–55, 58, 59)	**15**	**4.0**	**13**	**8.4**
Services (70–89)	**41**	**10.8**	**40**	**26.0**
Services (70–89, excluding 80 and 82)	19	5.0	16	10.4
Health Services (80)	15	4.0	19	12.3
Educational Services (82)	7	1.8	5	3.2
Public Administration (91–93, 95, 97)	**8**	**2.1**	**10**	**6.5**
Construction (15, 16, 17)	**13**	**3.4**	**5**	**3.2**
Other Categories (10, 13, 14, 60, 63–66)	**6**	**1.6**	**4**	**2.6**
TOTAL	**380***	**100.0**	**154**	**100.0**

*For one case, the industrial classification was not known.

TABLE 3. Occupational agents associated with reported cases of occupational asthma and related conditions — Michigan and New Jersey SENSOR programs, 1988–1992

	Michigan		New Jersey		Total	
Agent	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**
Isocyanates*	88	23.1	16	10.4	104	19.4
Coolant /oil mists from machining operations†	47	12.3	6	3.9	53	9.9
Aldehydes§	14	3.7	14	9.1	28	5.2
Epoxy resins	11	2.9	5	3.2	16	3.0
Tungsten carbide/cobalt	14	3.7	1	0.6	15	2.8
Acrylates	9	2.7	4	2.6	13	2.4
Chlorine	7	1.8	6	3.9	13	2.4
Acids	7	1.8	3	1.9	10	1.9
Diesel exhaust	2	0.5	8	5.2	10	1.9
Smoke/fumes, unspecified	10	2.6	0	0.0	10	1.9
Welding fumes	7	1.8	3	1.9	10	1.9
Pesticides/herbicides¶	1	0.3	8	5.2	9	1.7
Styrene	8	2.1	1	0.6	9	1.7
Amines**	5	1.3	3	1.9	8	1.5
Flour dust	5	1.3	2	1.3	7	1.3
Wood dust	3	0.8	4	2.6	7	1.3
Nondiesel exhaust	5	1.3	1	0.6	6	1.1
Phthalic anhydride	2	0.5	4	2.6	6	1.1
Chromium	5	1.3	0	0.0	5	0.9
Animals††	1	0.3	3	1.9	4	0.7
Benzalkonium chloride	0	0.0	4	2.6	4	0.7
Dusts, unspecified	0	0.0	4	2.6	4	0.7
Grain dust	4	1.0	0	0.0	4	0.7
Irritants, unspecified	0	0.0	4	2.6	4	0.7
Printing inks	4	1.0	0	0.0	4	0.7
Rose hips	4	1.0	0	0.0	4	0.7
Sodium hydroxide	4	1.0	0	0.0	4	0.7
Soldering agents/fumes§§	2	0.5	2	1.3	4	0.7
Ammonia	2	0.5	1	0.6	3	0.6
Enzymes	2	0.5	1	0.6	3	0.6
Latex/rubber	1	0.3	2	1.3	3	0.6
Mold	0	0.0	3	1.9	3	0.6
Sulfite	1	0.3	2	1.3	3	0.6
Cotton dust	0	0.0	2	1.3	2	0.4
Fibrous glass	0	0.0	2	1.3	2	0.4
Fluorocarbons¶¶	1	0.3	1	0.6	2	0.4
Furfural	0	0.0	2	1.3	2	0.4
Platinum salts	0	0.0	2	1.3	2	0.4
Sodium hypochlorite	0	0.0	2	1.3	2	0.4
Other agents***	5	1.3	19	12.3	24	4.5
Unidentified agents†††	100	26.2	9	5.8	109	20.4
Total	**381**	**100.0**	**154**	**100.0**	**535**	**100.0**

* Such as hexamethylene diisocyanate, toluene diisocyanate, and methylbisphenyl isocyanate.
† Such as oils used in drilling and grinding operations.
§ Such as formaldehyde and glutaraldehyde.
¶ Such as malathion and pyrethrins.
** Such as ethylenediamine and monoethanolamine.
†† Such as rats, mice, and bloodworms.
§§ Such as colophony.
¶¶ Such as chlorofluorocarbons and brominated fluorocarbons.
*** Includes one reported occurrence of each of the following agents: acetone, ammonium chloride, cigarette smoke, degreaser, ethanol, ethylene oxide, green coffee bean dust, gum arabic, hydrogen bromide, methylethyl ketone, morphine, ninhydrin, penicillin, perlite, persulfate, plastic fumes, radiographic developer, sodium benzoate, solvent unspecified, theatrical fog, toluene, trichloroethylene, vinyl acetate, and xylene.
††† Includes unidentified agents associated with cases reported in Michigan in the following industries/processes/settings: 64 manufacturing industry, 24 office-related, three pickle industry, two meat wrappers, two gas and oil refining, two construction industry, two cosmetology, and one photographic processing laboratory.

NJDOH also conducted repeat industrial hygiene evaluations at 14 previously inspected workplaces. The findings of these follow-up investigations generally indicated a high degree of compliance with recommendations made at earlier visits. Ten (71.4%) of the reinspected workplaces had attempted to improve the control of exposures to agents known to cause asthma, even though air sampling conducted at the initial inspection had indicated exposures lower than the enforceable PELs. Five (35.7%) workplaces had improved their worker training/hazard communication programs. Although compliance with recommendations to install new local exhaust ventilation systems was low (only one workplace out of six), most likely because of the high initial cost of such systems, six (42.8%) of the workplaces had taken actions to improve existing local exhaust ventilation systems. One common method for dealing with OA involved secondary prevention through administrative controls (e.g., affected workers were physically removed from exposure to the offending agent by reassignment and/or relocation).

DISCUSSION

OA is a disease characterized by variable airflow limitation and/or airway hyperresponsiveness resulting from an occupational exposure (*7*). OA may develop and become clinically evident in three general ways: 1) after a variable period of symptomless exposure to a sensitizing agent; 2) immediately following a single intense exposure to a known irritant—as in the case of RADS, the clinical signs and symptoms of which are identical to those of asthma; and 3) after a variable period of repeated exposures to lower doses of irritants. Studies of the natural history of OA indicate that, although many affected workers show clinical improvement when they are removed from the causative agent, most may continue to have episodes of asthma even after they are no longer exposed to the etiologic agent. Persistence of asthma appears to be related to the duration of continued occupational exposure following onset of the disease—which underscores the importance of controlling workplace exposures, seeking prompt diagnosis if asthma symptoms develop, and implementing preventive measures after a worker develops symptoms suggestive of asthma (*8*). Overall, more than 15% of asthma among adults may be attributable to workplace exposures (*9,10*); among certain worker groups, this proportion may be much higher. Thus, the occurrence of a case of OA is a sentinel health event indicating the need for public health intervention.

Hundreds of substances have been associated with OA, including isocyanates, anhydrides, epoxy resins, and certain animal proteins and plant products (*11,12*). Occupational exposure to many of these sensitizing agents is not specifically regulated by the Occupational Safety and Health Administration (OSHA). For those agents that do have mandated exposure limits (e.g., isocyanates), the limits are based on the irritant or other toxic properties of the chemical and are often not low enough to preclude sensitization of exposed workers or to prevent asthmatic reactions in workers who have already become sensitized. In addition, routine intermittent exposure monitoring—used to monitor compliance—is more likely to detect usual or typical concentrations of workplace agents than to measure occasional peak concentrations, which can result from spills or other unplanned exposures associated with activities such as maintenance and cleaning. Unplanned peak exposures are particularly likely to elicit severe asthmatic reactions in previously sensitized workers.

Although the SENSOR system was not designed to be a comprehensive surveillance system that would ascertain all cases of occupational asthma, SENSOR surveillance for OA has led to the identification of previously unrecognized causes of OA (*13,14*). Other notable results regarding state-based OA surveillance have been described (*5,15–17*). SENSOR surveillance for OA has played a critical role in setting priorities for public health actions, and findings have documented the need for more comprehensive control of such well-known occupational allergens as the isocyanates.

The use of OA surveillance data to target workplace inspections has proved beneficial. Industrial hygiene follow-up of workplaces where OA cases have occurred has identified substantial numbers of symptomatic coworkers and inadequacies in engineering controls and work practices. These findings have led to preventive measures by OSHA, health departments, and employers, even when documented worker exposures do not exceed a legally enforceable PEL.

Further development and refinement of this OA surveillance and intervention model are being supported by the second cycle of SENSOR cooperative agreements, which, since 1993, has funded OA projects in four states (California, Massachusetts, Michigan, and New Jersey). The goal of these projects is the development of a feasible, generalizable OA surveillance system appropriate for adoption by all interested state and territorial health departments.

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State and Territorial Epidemiologists and Laboratory Directors are gratefully acknowledged for their contributions to this report. The epidemiologists listed below were in the positions shown as of May 12, 1994, and the laboratory directors listed below were in the positions shown as of April 1994.

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