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Mortality Study of Employees at 3M Plant in Decatur, Alabama

A retrospective cohort mortality study of employees, who worked at least one year (beginning in March, 1961) at the 3M chemical and film plants in Decatur Alabama, was conducted by University of Minnesota epidemiologists to determine whether the mortality experience of these employees was significantly different from that which would be expected. The cohorts consisted of 1,050 and 1,116 men who were ever employed in the chemical and film plants, respectively. Of these male employees, 485 and 547 were only employed in the chemical and film plants, respectively. A total of 318 female employees were identified (both plants combined). Vital status was searched through December 31, 1991 and determined for 99.7% of the cohort. Of the 74 deceased employees, death certificates were obtained for 72 (97.3%). Standardized Morality Ratios (SMRs) were calculated using U.S., Alabama and a regional Alabama counties for comparisons. There was no significantly elevated SMRs. Investigators recommended the study be updated in 1998 to cover an additional five years of mortality experience.

3M, in conjunction with epidemiologists from the University of Minnesota Division of Occupational and Environmental Health are in the midst of completing this updated retrospective cohort mortality study. Several methodologic improvements have occurred since the original study. Since the completion of the original mortality study which abstracted only the beginning and stop dates of employment from work history data, 3M has now computerized the entire work history records of employees at the Decatur location. The computerization of this detailed job and department information, in conjunction with information about serum fluorochemical levels acquired from medical surveillance exams and the random sample (described above), will allow for the construction of a potential perfluorooctanesulfonate (PFOS) exposure matrix. This matrix will be used to more thoroughly assess the mortality experience of Decatur employees as it relates to the workers' occupational fluorochemical levels. Estimated date of the final report for this updated retrospective cohort mortality study is November 1, 2000.

FINAL REPORT

Mortality Study of Employees at 3M Plant in Decatur, Alabama

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Mortality Study of Employees at 3M Plant in Decatur, Alabama

Introduction

A retrospective cohort mortality study of employees who worked at least one year at the 3M Plant in Decatur, Alabama was conducted to determine whether the mortality experience of these employees was significantly different from that which would be expected in a comparable population. The major elements of the study were to: (1) define and completely enumerate the cohort; (2) ascertain pertinent employment information; (3) determine vital status as of December 31, 1991; (4) obtain death certificates for deceased cohort members and code the underlying causes of death; (5) select appropriate comparison populations; and (6) compare the number of deaths observed to the number of deaths expected, based on the mortality rates of the comparison populations.

Methods

Definition of Cohort

The cohort comprised all employees who had worked at least one year at the 3M Plant in Decatur, Alabama and at least one day after March 1, 1961. The cohort was followed from March 1, 1961 through December 31, 1991. March 1, 1961 was chosen as the begin date because 3M reported that the plant in Decatur began operations in March of 1961 and review of employment records revealed that very few employees started work prior to March 1, 1961. December 31, 1991 was chosen as the end date for the current follow-up study because National Death Index reporting was complete through that date.

Enumeration of Cohort and Ascertainment of Pertinent Employment Information

The 3M Plant at Decatur provided a computer file and computer-generated pages for 1,263 individuals actively employed anytime since 1986. The computer file only contained information about the most recent job or employment status, whereas the computer-generated page contained the entire job history. In addition, 3M provided photocopies of employment records for employees who were: (1) terminated during 1961 - 1971, (2) terminated since 1972, and (3) hired prior to 1986 and currently working.

To identify overlap among the record sources, a label was created for each employee in the computer file. If both a computer record and a photocopied employment record existed for an employee, the label was affixed to, and the computer-generated page was attached to, the photocopied employment record. Subsequently, new records were added to the study database for those employees who had photocopied employment records, but were not in the computer file. A total of 1,906 unique employees were added to the study database.

For all employees in the study database, the relevant employment information was abstracted from the photocopied employment records and/or computer generated pages. In those instances where there were minor discrepancies in employment dates between the photocopied employment record and the computer-generated page, the dates on the photocopied employment record were assumed to be correct.

Lists were sent to 3M for those employees for whom employment information was missing, insufficient, and/or inconsistent. 3M also was asked to provide missing demographic information (e.g., sex, date of birth, etc.) or information needed to determine the vital status of the employee or, if the employee was deceased, to obtain a copy of the death certificate. Where possible, 3M searched the Decatur Plant personnel records, corporate human resources computer databases, and microfilmed and microfiched corporate payroll records to provide additional information and resolve inconsistencies. However, despite 3M's efforts, a small number of employees were still missing a start date and/or end date. The date of first employment and the date of last employment are required for determining whether the employee worked for at least one year during the time period from March 1, 1961 through December 31, 1991. For such employees, either the employee was contacted directly and supplied the date(s) or a knowledgeable employee at the 3M Plant in Decatur estimated the date(s). The study databases and employment records were updated using the information provided by the various sources. Any information which remained missing was coded as unknown.

There were numerous quality control procedures to ensure the validity of information in the study database. Information acquired from the computer-generated pages or photocopied employment records, provided by 3M or its employees, or obtained during vital status follow-up was keyed and verified. All sources of information were reviewed to ensure that all eligible employees had been entered in the study database. The study database was examined for duplicate records. When duplicate records were identified, the best information from both records was combined into the first record and the second record was marked as a duplicate. A random sample of records was selected and key employment information was reabstracted to determine abstracting error rates and to identify any systematic errors which may have occurred. The data were checked in order to identify missing or inconsistent information and 3M was asked to follow-up on this information. A comprehensive error checking program was written to examine whether: (1) the individual values for key variables were acceptable, and (2) the values for key variables were consistent with one another. Errors identified by this program were resolved and the study database was updated.

The study database included 3,181 records. Of these, 12 were duplicate records and 1,212 were ineligible employees. A description of ineligible employees is shown below in Table 1.

Table 1: Description of Ineligible Employees in Study Database (n = 1,212)

Reason for Ineligibility	N
Worked Less Than One Year	1,210
Did Not Work at 3M Plant in Decatur	1
Not 3M Employee	1
TOTAL	1,212

Thus, a total of 1,957 eligible employees (1,639 males and 318 females) were included in the final cohort.

Follow-up of Cohort and Determination of Vital Status

For those employees for whom vital status was not known (including those reported as deceased, but for whom a death certificate had not been obtained), follow-up included computerized death searches via the: (1) National Death Index (NDI), (2) Equifax Death Search, and (3) TRW FACS+ Summary. In addition, some employees who terminated employment prior to 1979 were actively traced through driver's license records, relatives, neighbors, and/or coworkers.

A computer file of employees for whom vital status was not known was submitted to NDI for matching against information for the years 1979 - 1991.

Equifax has information about deaths reported to the Social Security Administration (SSA) and from sources such as the military, corporate pension plans, insurance companies, etc. A computer file of employees for whom vital status was not known was submitted to Equifax.

TRW FACS+ Summary contains information about deaths and is maintained by the Credit Reporting Division of TRW. The majority of death information contained in TRW also is provided by the SSA. TRW was used to search for deaths among employees for whom vital status was not known. Currently, TRW typically provides the name, date of birth, and date of death for individuals who have been reported deceased. Throughout most of the study, however, TRW only provided information that there had been a reported death associated with the social security number, without providing additional identifying information or death information.

Because all of the computerized death searches were dependent upon having the correct social security number for an employee, efforts were made to ensure the accuracy of social security numbers. In addition to comparing social security numbers from the various sources of information (i.e., the computer file, employment records, etc.), TRW Social Search was used to verify the accuracy of social security numbers for employees. Some social security numbers were not found in TRW. For these employees, the social security numbers were assumed to be correct because there are a number of valid reasons why a person may not be included in TRW (e.g., a person may ask to be removed from the TRW file or a person may not have any credit activity). Additional tracing was done to resolve discrepancies in social security numbers.

Active tracing of employees was performed for all employees who terminated prior to 1979 (when NDI was implemented) and for whom vital status was not previously known. Driver's license records frequently were used to determine vital status. In addition, interactive software was used to access Metronet, a national consumer database, and addresses and/or telephone numbers of relatives, neighbors, and/or former employees were obtained. Other tracing sources included other 3M employees and law enforcement agencies. Once a tracing lead was identified, telephone tracers followed up to determine, directly or indirectly, the vital status of the employee.

The results of the vital status follow-up, along with the employment status as of the study end date, are shown in Tables 2 and 3 for males and females, respectively.

Table 2: Description of Final Employment Status and Vital Status for Men (n = 1,639)

Final Employment Status and Vital Status	N	%
Currently Employed	810	49.4
Retired		
Alive	59	3.6
Dead	10	0.6
Unknown	0	0.0
Terminated		
Alive	694	42.3
Dead	29	1.8
Unknown	6	0.4
Died While Employed	31	1.9
TOTAL	1,639	100.0*

* percentages may not add to 100 due to rounding

Table 3: Description of Final Employment Status and Vital Status for Women (n = 318)

Final Employment Status and Vital Status	N	%
Currently Employed	141	44.3
Retired		
Alive	9	2.8
Dead	0	0.0
Unknown	0	0.0
Terminated		
Alive	164	51.6
Dead	1	0.3
Unknown	0	0.0
Died While Employed	3	0.9
TOTAL	318	100.0*

* percentages may not add to 100 due to rounding

Six (0.3%) employees were lost to follow-up. For these employees, the last known date that the employee was alive is the date of termination of employment. A description of the employees who were lost to follow-up is shown in Table 4.

Table 4: Description of Employees Lost to Follow-up (n = 6)

Study ID	Sex	Month/Year of Birth	Month/Year of Employment	Job Title(s)
20067	male	08/49	08/73 - 10/75	general helper, process helper, material handler, resin handler
20958	male	12/37	02/65 - 02/71	general helper, process helper, process operator, chemical operator, foreman
21028	male	06/41	01/66 - 07/68	general helper, process helper, process operator, chemical operator
21057	male	01/46	04/66 - 07/67	general helper, process helper, process operator
21184	male	11/46	08/66 - 03/69	general helper, process operator
21639	male	08/45	01/69 - 09/77	general helper, process helper, packer, material handler helper, material handler, process operator, warehouseman, order filler, chemical operator

Obtaining and Coding of Death Certificates

Death certificates were requested from state vital statistics offices. If a death certificate could not be obtained or the death certificate obtained was not for the correct person, additional tracing was implemented. Overall, 72 (97.3%) death certificates were obtained for the 74 deceased employees (70 men and 4 women). A description of the state of residence at time of death for the 72 deceased employees for whom a death certificate was obtained is provided in Table 5. Ninety percent died in Alabama.

Table 5: Description of State of Residence at Time of Death for Deceased Employees for Whom a Death Certificate Was Obtained (n = 72)

State	N
Alabama	65
Florida	1
Georgia	1
Michigan	1
Minnesota	1
Ohio	1
Tennessee	1
Texas	1
TOTAL	72

The distribution of deaths by calendar year is shown in Table 6.

Table 6: Distribution of Deaths by Year of Death (n = 74)

Year of Death	N
1967 - 1969	3
1970 - 1974	9
1975 - 1979	9
1980 - 1984	12
1985 - 89	33
1990 - 1991	8
TOTAL	74

Death certificates were coded by a professional nosologist according to the Eighth Revision of the International Classification of Diseases (ICD 8). The underlying cause of death and any mention of cancer were coded.

Selection of Comparison Populations

Three comparison populations were selected: (1) the U.S., (2) the state of Alabama, and (3) Alabama counties where more than one-half of the county was within 100 miles of Decatur, excluding those counties in which there was a city with greater than 100,000 persons. Counties included in the regional comparison were: (1) Blount, (2) Calhoun, (3) Cherokee, (4) Colbert, (5) Cullman, (6) De Kalb, (7) Etowah, (8) Fayette, (9) Franklin, (10) Jackson, (11) Lamar, (12) Lauderdale, (13) Lawrence, (14) Limestone, (15) Marion, (16) Marshall, (17) Morgan, (18) St. Clair, (19) Shelby, (20) Talladega, (21) Tuscaloosa, (22) Walker, and (23) Winston. Based upon 1990 census figures, the combined population for these counties was 1,387,615 persons. Counties excluded due to a population center of 100,000 persons or more were: (1) Madison (large city is Huntsville), and (2) Jefferson (large city is Birmingham).

Race-, sex-, age-, and time-specific mortality rates, adjusted to ICD 8, were obtained for the three comparison populations from the Mortality and Population Data System (MPDS) at the University of Pittsburgh. No mortality rates are available from the MPDS prior to 1950 and only cancer mortality rates are available prior to 1962. The most current mortality rates available are for 1989.

Study Database

The final study database was a combination of data from the following sources: the computer file, computer-generated pages, photocopied employment records, 3M, employees, tracing/vital status follow-up, and death certificates. The following key information was available in the study database:

- study ID;
- first name, middle name, and last name;
- street address, city, state, and zip code;
- telephone number;
- social security number;
- sex;
- date of birth;

- date of first employment at 3M Plant in Decatur;
- date of last employment at 3M Plant in Decatur;
- number of lapsed months between date of first employment and date of last employment when not actually working at 3M Plant in Decatur;
- date first employed in chemical department(s);
- date last employed in chemical department(s);
- number of months worked in chemical department(s) (accounting for any lapses when not actually working in chemical department(s));
- flags indicating work in specific department(s) (i.e., worked in chemical department(s), worked in film department(s), etc.);
- final employment status (i.e., currently working, retired, otherwise terminated from employment, died while employed);
- vital status (i.e., alive, presumed alive, deceased, or unknown);
- date of death or date last known to be alive (if different from last date of employment or date of termination);
- underlying cause of death coded to ICD 8; and
- contributing causes of death or other significant conditions (if cancer) coded to ICD 8.

The necessary data files for analysis were prepared using the key information contained in the study database. As part of this process, default values were automatically substituted for any missing components of employment dates (i.e., 06 for a missing month and 15 for a missing day). If this automatic substitution for missing dates created a date that was chronologically out of sequence, a date was manually estimated and this estimated date was entered in the study database.

Analysis

The method of analysis was based upon a comparison of the observed to expected numbers of deaths specific for the cause of death, race, sex, age, and time. The estimate of the expected number of deaths was calculated by applying cause-, race-, sex-, age-, and time-specific rates for the comparison population to the person-years at risk. Follow-up began March 1, 1961. Cohort members did not contribute person-years until they had met the minimum length of work criterion (i.e., one year or more). Person-years of follow-up were contributed until death, lost to follow-up, or the end of the study (December 31, 1991). No information on race was available; thus, employees were assumed to be white. Deceased study members for whom a death certificate could not be obtained only were included in the "all causes of death" and "unknown cause of death" categories.

Standardized mortality ratios (SMRs) were computed using the Occupational Cohort Mortality Analysis Program (OCMAP).[1] Mortality rates for whites were used to calculate the expected numbers for all men and all women. For 1961, when mortality rates for noncancer causes were unavailable, the expected numbers of deaths were not calculated (i.e., the expected numbers of deaths were set to zero). There were no observed deaths prior to 1967. Mortality rates for 1989 were used to estimate mortality rates for subsequent years. SMRs were calculated using both OCMAP and the United States Death Rates (USDR) program developed by Monson.[2] Results were virtually identical.

The overall pattern of mortality was examined for men and women. For men, the pattern of mortality by department(s) worked also was examined. For this analysis, the following subgroups of employees were defined: (1) ever employed in the chemical department(s); (2) only employed in the chemical department(s); (3) ever employed in the film department(s); and (4) only employed in the film department(s). Department codes at the 3M Decatur Plant were defined by four-digit codes. The first two digits were '59' for film departments and were '76' for chemical departments. For 11 employees, at least one department was unknown; and, for 3 of these, all departments were unknown. Thus, these 3 employees could not be included in the subgroup analysis by department(s) worked.

Results

Characteristics of male and female cohort members are given in Tables 7 and 8, respectively. Men contributed 33,108 person-years of follow-up and women contributed 4,807 person-years. There were 70 (95%) deaths among men and 4 (5%) among women. On average, men entered the cohort at an earlier point in time (1971 versus 1977) and at a slightly younger age than women (25 versus 26).

Table 7: Characteristics of Men (n = 1,639)

Variable	Value
Number of Employees	1,639
Number of Person-Years	33,108
Number of Deaths	70
Average Age Started Work	25
Average Year of Entry	1971
Average Age at Death	47
Average Year of Death	1984

Table 8: Characteristics of Women (n = 318)

Variable	Value
Number of Employees	318
Number of Person-Years	4,807
Number of Deaths	4
Average Age Started Work	26
Average Year of Entry	1977
Average Age at Death	28
Average Year of Death	1980

In Table 9, the distribution of men by age and year of entry into follow-up is shown. Table 10 shows the same distribution for women. Most men entered the cohort during the late 1960s and early 1970s and between the ages of 20 and 30, whereas most women entered the cohort at similar ages, but between 1970 and 1980.

Table 9: Distribution of Men by Age and Year of Entry into Follow-up (n = 1,639)

	Year of Entry into Follow-up							
Age	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1991	TOTAL
<20	18	34	86	31	4	2	0	175
20 - 24	114	238	301	96	28	18	3	798
25 - 29	64	139	65	37	21	14	5	345
30 - 34	21	58	33	19	8	10	4	153
35 - 39	22	25	9	15	6	5	1	83
40 - 44	19	18	4	10	8	2	0	61
45 - 49	3	3	4	5	0	2	0	17
50 - 54	0	1	0	0	2	3	0	6
55 - 59	0	1	0	0	0	0	0	1
60+	0	0	0	0	0	0	0	0
TOTAL	261	517	502	213	77	56	13	1,639

Table 10: Distribution of Women by Age and Year of Entry into Follow-up (n = 318)

	Year of Entry into Follow-up							
Age	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1991	TOTAL
<20	2	12	18	16	4	0	0	52
20 - 24	4	22	23	50	4	9	1	113
25 - 29	3	4	4	47	4	5	3	70
30 - 34	2	3	2	15	1	4	2	29
35 - 39	1	2	3	16	3	3	2	30
40 - 44	0	0	0	8	3	2	0	13
45 - 49	0	0	0	5	1	1	0	7
50 - 54	0	0	0	3	0	0	0	3
55 - 59	0	0	0	1	0	0	0	1
60+	0	0	0	0	0	0	0	0
TOTAL	12	43	50	161	20	24	8	318

Tables 11 and 12 provide the distribution of person-years by age and calendar period for men and women, respectively.

Table 11: Distribution of Person-Years for Men by Age and Calendar Period (n = 1,639)

	Calendar Period							
Age	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1991	TOTAL*
<20	9	19	43	23	2	1	0	96
20 - 24	182	583	985	930	244	64	21	3,008
25 - 29	124	861	1,530	1,633	1,171	341	66	5,724
30 - 34	60	463	1,254	1,672	1,728	1,228	208	6,613
35 - 39	50	188	609	1,339	1,716	1,760	636	6,297
40 - 44	35	129	272	645	1,390	1,719	738	4,927
45 - 49	21	91	180	295	665	1,387	630	3,270
50 - 54	0	28	103	184	308	650	456	1,728
55 - 59	0	5	27	101	185	307	204	827
60 - 64	0	0	5	27	101	174	96	402
65 - 69	0	0	0	5	24	86	47	161
70 - 74	0	0	0	0	5	18	25	47
75 - 79	0	0	0	0	0	5	1	5
80 - 84	0	0	0	0	0	0	2	2
85+	0	0	0	0	0	0	0	0
TOTAL*	479	2,365	5,006	6,853	7,536	7,739	3,129	33,108

* totals may not be equal to sum of individual rows or columns due to rounding

Table 12: Distribution of Person-Years for Women by Age and Calendar Period (n = 318)

	Calendar Period							
Age	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1991	TOTAL*
<20	1	9	20	21	12	0	0	63
20 - 24	9	65	138	182	139	38	5	576
25 - 29	7	39	115	253	337	171	34	955
30 - 34	2	19	55	171	376	346	106	1,074
35 - 39	2	14	26	81	235	383	160	900
40 - 44	2	5	17	48	136	243	143	594
45 - 49	0	2	5	24	70	141	91	332
50 - 54	0	0	2	8	49	70	43	172
55 - 59	0	0	0	3	18	49	19	89
60 - 64	0	0	0	0	5	18	18	41
65 - 69	0	0	0	0	0	5	7	12
70 - 74	0	0	0	0	0	0	0	0
75 - 79	0	0	0	0	0	0	0	0
80 - 84	0	0	0	0	0	0	0	0
85+	0	0	0	0	0	0	0	0
TOTAL*	22	153	377	790	1,377	1,463	624	4,807

* totals may not be equal to sum of individual rows or columns due to rounding

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The distribution of the absolute number of persons at risk by calendar period is provided in Table 13 for men and in Table 14 for women.

Table 13: Distribution of Absolute Number at Risk by Calendar Period for Men (n = 1,639)

Calendar Period	Number at Risk
1960 - 1964	261
1965 - 1969	778
1970 - 1974	1,274
1975 - 1979	1,477
1980 - 1984	1,545
1985 - 1989	1,591
1990 - 1991	1,571
TOTAL	1,639

Table 14: Distribution of Absolute Number at Risk by Calendar Period for Women (n = 318)

Calendar Period	Number at Risk
1960 - 1964	12
1965 - 1969	55
1970 - 1974	105
1975 - 1979	266
1980 - 1984	284
1985 - 1989	306
1990 - 1991	314
TOTAL	318

In the tables which follow, the observed number of deaths, the expected number of deaths, the observed to expected ratio (i.e., the SMR), and the 95% confidence interval (95% CI) are shown for specific causes of death. The observed number of deaths for a specific cause is the number of deaths from that cause that occurred during the study time period. The expected number of deaths for a specific cause is the number of deaths that would have occurred if the employees experienced the same cause-specific mortality rates as observed in the comparison population. The expected number of deaths was calculated by applying the race-, sex-, age-, and time period-specific rates for the comparison population to the number of person-years of follow-up contributed by the cohort members. The observed number of deaths for a specific cause was divided by the expected number of deaths for that cause and multiplied by 100 to obtain the cause-specific SMR. An SMR may be interpreted as follows: (1) an SMR of 100 means that the observed and expected number of deaths were equal, (2) an SMR less than 100 means that fewer deaths occurred than expected, and (3) an SMR greater than 100 means more deaths occurred than expected. The 95% CI for the SMR provides an indication of the variability and statistical significance of the estimate of the SMR. The 95% CI means that there is a 95% chance that the interval includes the true value of the SMR. If the 95% CI does not include 100, the SMR is considered statistically significant.

In Table 15, SMRs for men are presented for selected cause of death categories for each of the three white comparison populations.

Table 15: Selected Cause-Specific SMRs for Men by Comparison Population (n = 1,639)

		SMR (95% Confidence Interval)		
		Comparison Population		
Cause of Death	Observed Deaths	U.S.	Alabama	Alabama Counties
All Causes of Death	70	62.9	54.8	52.0
		(49.0, 79.5)	(42.7, 69.3)	(40.5, 65.7)
All Malignant Neoplasms	15	68.4	60.9	59.9
		(38.3, 112.8)	(34.1, 100.4)	(33.5, 98.8)
Cerebrovascular Disease	1	33.5	27.8	26.5
		(0.8, 186.8)	(0.7, 155.2)	(0.7, 147.5)
All Heart Disease	17	59.1	53.2	49.1
		(34.4, 94.7)	(31.0, 85.1)	(28.6, 78.6)
Respiratory Disease	0	—	—	—
		(0.0, 91.2)	(0.0, 80.2)	(0.0, 73.9)
External Causes	25	74.5	59.0	55.0
		(48.2, 110.0)	(38.2, 87.1)	(35.6, 81.3)

SMRs based upon the Alabama and Alabama counties comparison populations were similar to, but lower than, those based upon the U.S. comparison population. Since the U.S death rates are more stable than the death rates for the state and regional comparison populations and because the U.S. commonly is used as a comparison population in occupational cohort mortality studies, SMRs based upon the U.S. comparison population will be presented in the results which follow. SMRs for men and women based upon the Alabama and Alabama counties comparison populations are provided in Tables 22 through 25 in the appendices.

There were 70 deaths among the men in this cohort. Using the U.S. as the comparison population, SMRs for men are shown in Table 16. The SMRs for all causes of death, heart disease, and respiratory disease (i.e., nonmalignant respiratory disease) were significantly less than 100. The SMR for all causes of death was 62.9 (95% CI = 49.0, 79.5) and the SMR for heart disease was 59.1 (95% CI = 34.4, 94.7). No respiratory disease deaths occurred, although 4 deaths were expected.

Other deficits occurred for all cancer and external causes of death. The SMR for all cancers was 68.4 (95% CI = 38.3, 112.8). Most of the specific cancer SMRs were less than 100, except for cancer of the bladder and other urinary organs and cancer of other lymphatic and hematopoietic tissue. For these two causes, the SMRs were based on only one or two deaths and were not statistically significant. For external causes of death, the SMR was 74.5 (95% CI = 48.2, 110.0). Less than the expected number of deaths occurred for motor vehicle accidents, suicides, and homicides and other external causes of death.

Table 16: Cause-Specific SMRs for Men Using the U.S. as Comparison Population (n = 1,639)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	70	111.3	62.9	(49.0, 79.5)
All Malignant Neoplasms	15	21.9	68.4	(38.3, 112.8)
Cancer of Buccal Cavity and Pharynx	0	0.6	—	(0.0, 628.2)
Cancer of Digestive Organs and Peritoneum	1	4.7	21.5	(0.5, 120.0)
Cancer of Esophagus	0	0.5	—	(0.0, 722.6)
Cancer of Stomach	0	0.7	—	(0.0, 531.8)
Cancer of Large Intestine	1	1.7	60.2	(1.5, 335.3)
Cancer of Rectum	0	0.4	—	(0.0, 1,003.1)
Cancer of Liver and Biliary Passages	0	0.4	—	(0.0, 919.1)
Cancer of Pancreas	0	1.0	—	(0.0, 379.1)
Cancer of All Other Digestive Organs	0	0.2	—	(0.0, 2,442.9)
Cancer of Respiratory System	7	7.6	91.8	(36.9, 189.2)
Cancer of Larynx	0	0.2	—	(0.0, 1,529.7)
Cancer of Bronchus, Trachea, and Lung	7	7.3	96.4	(38.7, 198.6)
Cancer of Other Respiratory Organs	0	0.1	—	(0.0, 3,109.0)
Cancer of Prostate	0	0.5	—	(0.0, 694.6)
Cancer of Testes and Other Male Genital Organs	0	0.3	—	(0.0, 1,123.9)
Cancer of Kidney	0	0.6	—	(0.0, 592.5)
Cancer of Bladder and Other Urinary Organs	1	0.3	341.3	(8.5, 1,901.6)

Table 16: (Continued)				

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	1	1.2	84.3	(2.1, 470.0)
Cancer of Thyroid and Other Endocrine Glands	0	0.1	---	(0.0, 3,749.2)
Cancer of Bone	0	0.1	---	(0.0, 3,035.4)
Cancer of All Lymphatic and Hematopoietic Tissue	3	3.0	101.1	(20.9, 295.5)
Lymphoma	0	0.4	---	(0.0, 997.3)
Hodgkin's Disease	0	0.5	---	(0.0, 804.7)
Leukemia and Aleukemia	1	1.2	86.4	(2.2, 481.4)
Cancer of Other Lymphatic and Hematopoietic Tissue	2	1.0	203.8	(24.7, 736.2)
Malignant Melanoma of Skin	1	0.9	116.8	(2.9, 650.6)
All Other Malignant Neoplasms	1	1.9	52.2	(1.3, 290.7)
Diabetes Mellitus	0	1.5	---	(0.0, 240.2)
Cerebrovascular Disease	1	3.0	33.5	(0.8, 186.8)
All Heart Disease	17	28.8	59.1	(34.4, 94.7)
Hypertension	0	0.1	---	(0.0, 2,652.5)
Respiratory Disease	0	4.0	---	(0.0, 91.2)
Ulcer of Stomach and Duodenum	0	0.3	---	(0.0, 1,407.9)
Cirrhosis of Liver	3	4.1	73.7	(15.2, 215.3)
Nephritis and Nephrosis	0	0.4	---	(0.0, 999.6)
External Causes	25	33.5	74.5	(48.2, 110.0)
Accidents	19	20.6	92.4	(55.6, 144.2)
Motor Vehicle Accidents	9	11.8	76.1	(34.8, 144.5)
All Other Accidents	10	8.8	113.6	(54.5, 208.9)
Suicides	4	7.9	50.8	(13.9, 130.1)

Table 16: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	2	4.9	40.7	(4.9, 147.0)
Residual Causes*	7	12.8	54.5	(21.9, 112.3)
Unknown Causes†	2			

* all other causes of death combined
† no death certificate obtained; included only in all causes of death category

In Table 17, SMRs are provided for women, using the U.S. as the comparison population. No cause of death had an SMR significantly different from 100. There were 4 deaths among female employees and the all cause SMR was 62.6 (95% CI = 17.1, 160.4). Of the 4 deaths which occurred, 3 deaths were from external causes (SMR = 213.4; 95% CI = 44.0, 623.6). By examining the death certificates for the specific causes of death and circumstances surrounding the deaths, it was determined that the excess mortality among females due to external causes was not work-related. One of the external causes of death was due to arsenic poisoning and the other two external causes of death were due to motor vehicle accidents.

Table 17: Cause-Specific SMRs for Women Using the U.S. as Comparison Population (n = 318)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	4	6.4	62.6	(17.1, 160.4)
All Malignant Neoplasms	0	2.3	---	(0.0, 162.4)
Cerebrovascular Disease	1	0.3	376.0	(9.4, 2,095.3)
All Heart Disease	0	0.9	---	(0.0, 413.1)
Respiratory Disease	0	0.3	---	(0.0, 1,344.7)
External Causes	3	1.4	213.4	(44.0, 623.6)
Accidents	2	0.8	247.3	(29.9, 893.4)
Motor Vehicle Accidents	2	0.6	364.7	(44.1, 1,317.6)
All Other Accidents	0	0.3	---	(0.0, 1,445.3)
Suicides	0	0.4	---	(0.0, 992.2)
Homicides and Other External Causes	1	0.2	449.6	(11.2, 2,505.4)

Tables 18 through 21 present SMRs and 95% CIs for men by the department(s) worked subgroups.

Findings were similar for men ever employed in chemical department(s) (Table 18). A total of 57 deaths were observed for these men and the all cause SMR was significantly decreased (SMR = 70.0; 95% CI = 53.0, 90.6). The SMR for heart disease also was significantly less than 100 (SMR = 48.8; 95% CI = 24.4, 87.4). SMRs and 95% CIs for all cancer and external causes of death were 76.9 (95% CI = 40.9, 131.5) and 90.2 (95% CI = 55.1, 139.3), respectively.

Table 18: Cause-Specific SMRs for Men Ever Employed in Chemical Department(s) Using the U.S. as Comparison Population (n = 1,050)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	57	81.5	70.0	(53.0, 90.6)
All Malignant Neoplasms	13	16.9	76.9	(40.9, 131.5)
Cancer of Buccal Cavity and Pharynx	0	0.5	—	(0.0, 800.6)
Cancer of Digestive Organs and Peritoneum	1	3.6	27.5	(0.7, 153.2)
Cancer of Esophagus	0	0.4	—	(0.0, 913.3)
Cancer of Stomach	0	0.5	—	(0.0, 686.1)
Cancer of Large Intestine	1	1.3	76.9	(1.9, 428.5)
Cancer of Rectum	0	0.3	—	(0.0, 1,271.9)
Cancer of Liver and Biliary Passages	0	0.3	—	(0.0, 1,188.2)
Cancer of Pancreas	0	0.8	—	(0.0, 480.6)
Cancer of All Other Digestive Organs	0	0.1	—	(0.0, 3,203.2)
Cancer of Respiratory System	7	6.1	115.1	(46.3, 237.1)
Cancer of Larynx	0	0.2	—	(0.0, 1,891.9)
Cancer of Bronchus, Trachea, and Lung	7	5.8	120.7	(48.5, 248.7)
Cancer of Other Respiratory Organs	0	0.1	—	(0.0, 4,214.1)
Cancer of Prostate	0	0.5	—	(0.0, 805.9)
Cancer of Testes and Other Male Genital Organs	0	0.2	—	(0.0, 1,678.5)
Cancer of Kidney	0	0.5	—	(0.0, 768.2)
Cancer of Bladder and Other Urinary Organs	1	0.2	415.5	(10.4, 2,315.3)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	1	0.9	117.2	(2.9, 653.0)
Cancer of Thyroid and Other Endocrine Glands	0	0.1	—	(0.0, 5,113.2)
Cancer of Bone	0	0.1	—	(0.0, 4,368.3)
Cancer of All Lymphatic and Hematopoietic Tissue	2	2.2	92.9	(11.2, 335.5)
Lymphoma	0	0.3	—	(0.0, 1,341.4)
Hodgkin's Disease	0	0.3	—	(0.0, 1,163.3)
Leukemia and Aleukemia	1	0.8	120.0	(3.0, 668.8)
Cancer of Other Lymphatic and Hematopoietic Tissue	1	0.7	137.2	(3.4, 764.5)
Malignant Melanoma of Skin	0	0.6	—	(0.0, 614.7)
All Other Malignant Neoplasms	1	1.5	68.9	(1.7, 383.7)
Diabetes Mellitus	0	1.1	—	(0.0, 323.9)
Cerebrovascular Disease	1	2.3	43.4	(1.1, 241.7)
All Heart Disease	11	22.5	48.8	(24.4, 87.4)
Hypertension	0	0.1	—	(0.0, 3,389.9)
Respiratory Disease	0	3.2	—	(0.0, 116.3)
Ulcer of Stomach and Duodenum	0	0.2	—	(0.0, 1,796.3)
Cirrhosis of Liver	3	3.0	100.2	(20.7, 292.7)
Nephritis and Nephrosis	0	0.3	—	(0.0, 1,308.2)
External Causes	20	22.2	90.2	(55.1, 139.3)
Accidents	16	13.6	117.3	(67.0, 190.5)
Motor Vehicle Accidents	8	7.8	102.8	(44.4, 202.5)
All Other Accidents	8	5.9	135.7	(58.6, 267.4)
Suicides	3	5.2	57.7	(11.9, 168.6)

Table 18: (Continued)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	1	3.2	31.4	(0.8, 175.1)
Residual Causes*	7	9.0	77.6	(31.2, 159.9)
Unknown Causes†	2			

* all other causes of death combined

† no death certificate obtained; included only in all causes of death category

Thirty-two deaths occurred among men only employed in chemical department(s) (Table 19). The SMR for all causes of death was 72.5 and was not statistically significant (95% CI = 49.6, 102.4). For heart disease, the SMR was 53.4 (95% CI = 21.5, 110.1). The all cancer SMR was 93.6 (95% CI = 42.8, 177.8). The observed and expected numbers of deaths due to external causes were approximately the same, resulting in an SMR of 95.0 (95% CI = 45.6, 174.7).

Table 19: Cause-Specific SMRs for Men Only Employed in Chemical Department(s) Using the U.S. as Comparison Population (n = 485)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	32	44.1	72.5	(49.6, 102.4)
All Malignant Neoplasms	9	9.6	93.6	(42.8, 177.8)
Cancer of Buccal Cavity and Pharynx	0	0.3	---	(0.0, 1,396.4)
Cancer of Digestive Organs and Peritoneum	0	2.1	---	(0.0, 175.2)
Cancer of Esophagus	0	0.2	---	(0.0, 1,577.7)
Cancer of Stomach	0	0.3	---	(0.0, 1,195.2)
Cancer of Large Intestine	0	0.8	---	(0.0, 488.5)
Cancer of Rectum	0	0.2	---	(0.0, 2,175.6)
Cancer of Liver and Biliary Passages	0	0.2	---	(0.0, 2,072.6)
Cancer of Pancreas	0	0.5	---	(0.0, 827.2)
Cancer of All Other Digestive Organs	0	0.1	---	(0.0, 5,692.4)
Cancer of Respiratory System	5	3.6	141.0	(45.8, 329.0)
Cancer of Larynx	0	0.1	---	(0.0, 3,198.4)
Cancer of Bronchus, Trachea, and Lung	5	3.4	147.8	(48.0, 344.9)
Cancer of Other Respiratory Organs	0	0.1	---	(0.0, 7,763.4)
Cancer of Prostate	0	0.3	---	(0.0, 1,202.0)
Cancer of Testes and Other Male Genital Organs	0	0.1	---	(0.0, 3,501.4)
Cancer of Kidney	0	0.3	---	(0.0, 1,365.0)
Cancer of Bladder and Other Urinary Organs	1	0.2	669.9	(16.7, 3,732.7)

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Table 19: (Continued)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	1	0.5	222.6	(5.6, 1,240.3)
Cancer of Thyroid and Other Endocrine Glands	0	0.0	—	(0.0, 9,544.3)
Cancer of Bone	0	0.0	—	(0.0, 8,697.5)
Cancer of All Lymphatic and Hematopoietic Tissue	2	1.2	174.0	(21.1, 628.7)
Lymphoma	0	0.2	—	(0.0, 2,466.1)
Hodgkin's Disease	0	0.2	—	(0.0, 2,346.1)
Leukemia and Aleukemia	1	0.4	226.3	(5.7, 1,260.7)
Cancer of Other Lymphatic and Hematopoietic Tissue	1	0.4	249.5	(6.2, 1,390.1)
Malignant Melanoma of Skin	0	0.3	—	(0.0, 1,200.4)
All Other Malignant Neoplasms	0	0.8	—	(0.0, 455.3)
Diabetes Mellitus	0	0.6	—	(0.0, 589.0)
Cerebrovascular Disease	0	1.3	—	(0.0, 274.4)
All Heart Disease	7	13.1	53.4	(21.5, 110.1)
Hypertension	0	0.1	—	(0.0, 5,834.4)
Respiratory Disease	0	1.9	—	(0.0, 195.3)
Ulcer of Stomach and Duodenum	0	0.1	—	(0.0, 3,083.3)
Cirrhosis of Liver	1	1.6	62.3	(1.6, 347.3)
Nephritis and Nephrosis	0	0.2	—	(0.0, 2,346.9)
External Causes	10	10.5	95.0	(45.6, 174.7)
Accidents	9	6.5	139.4	(63.7, 264.5)
Motor Vehicle Accidents	5	3.6	138.0	(44.8, 322.0)
All Other Accidents	4	2.9	140.2	(38.2, 359.0)
Suicides	1	2.5	40.0	(1.0, 223.1)

Table 19: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	0	1.5	---	(0.0, 247.4)
Residual Causes*	3	4.7	63.4	(13.1, 185.3)
Unknown Causes†	2			

* all other causes of death combined
† no death certificate obtained; included only in all causes of death category

There were 37 deaths among men ever employed in film department(s) (Table 20). A statistically significant deficit was observed for all causes of death combined (SMR = 58.6; 95% CI = 41.3, 80.8). Although nonsignificant, deficits also were seen for heart disease (SMR = 69.9; 95% CI = 33.5, 128.5), all cancer (SMR = 52.9; 95% CI = 19.4, 115.2), and external causes of death (SMR = 62.9; 95% CI = 34.4, 105.5).

Table 20: Cause-Specific SMRs for Men Ever Employed in Film Department(s) Using the U.S. as Comparison Population (n = 1,116)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	37	63.1	58.6	(41.3, 80.8)
All Malignant Neoplasms	6	11.3	52.9	(19.4, 115.2)
Cancer of Buccal Cavity and Pharynx	0	0.3	---	(0.0, 1,248.9)
Cancer of Digestive Organs and Peritoneum	1	2.3	43.1	(1.1, 240.0)
Cancer of Esophagus	0	0.3	---	(0.0, 1,465.1)
Cancer of Stomach	0	0.4	---	(0.0, 1,043.7)
Cancer of Large Intestine	1	0.8	120.6	(3.0, 672.1)
Cancer of Rectum	0	0.2	---	(0.0, 2,040.6)
Cancer of Liver and Biliary Passages	0	0.2	---	(0.0, 1,798.6)
Cancer of Pancreas	0	0.5	---	(0.0, 767.6)
Cancer of All Other Digestive Organs	0	0.1	---	(0.0, 4,625.3)
Cancer of Respiratory System	2	3.7	54.1	(6.5, 195.4)
Cancer of Larynx	0	0.1	---	(0.0, 3,253.4)
Cancer of Bronchus, Trachea, and Lung	2	3.5	56.9	(6.9, 205.4)
Cancer of Other Respiratory Organs	0	0.1	---	(0.0, 5,537.8)
Cancer of Prostate	0	0.2	---	(0.0, 1,915.6)
Cancer of Testes and Other Male Genital Organs	0	0.2	---	(0.0, 1,711.8)
Cancer of Kidney	0	0.3	---	(0.0, 1,137.8)
Cancer of Bladder and Other Urinary Organs	0	0.1	---	(0.0, 2,877.2)

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Table 20: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	0	0.7	---	(0.0, 531.1)
Cancer of Thyroid and Other Endocrine Glands	0	0.1	---	(0.0, 6,576.8)
Cancer of Bone	0	0.1	---	(0.0, 4,865.3)
Cancer of All Lymphatic and Hematopoietic Tissue	1	1.7	58.4	(1.5, 325.5)
Lymphoma	0	0.2	---	(0.0, 1,785.5)
Hodgkin's Disease	0	0.3	---	(0.0, 1,276.9)
Leukemia and Aleukemia	0	0.7	---	(0.0, 545.8)
Cancer of Other Lymphatic and Hematopoietic Tissue	1	0.5	184.8	(4.6, 1,030.0)
Malignant Melanoma of Skin	1	0.5	191.8	(4.8, 1,058.8)
All Other Malignant Neoplasms	1	1.0	97.6	(2.4, 543.7)
Diabetes Mellitus	0	0.9	---	(0.0, 434.3)
Cerebrovascular Disease	1	1.5	66.3	(1.7, 369.6)
All Heart Disease	10	14.3	69.9	(33.5, 128.5)
Hypertension	0	0.1	---	(0.0, 5,311.6)
Respiratory Disease	0	2.0	---	(0.0, 187.3)
Ulcer of Stomach and Duodenum	0	0.1	---	(0.0, 2,826.0)
Cirrhosis of Liver	2	2.3	86.6	(10.5, 312.7)
Nephritis and Nephrosis	0	0.2	---	(0.0, 1,870.8)
External Causes	14	22.3	62.9	(34.4, 105.5)
Accidents	10	13.7	73.2	(35.1, 134.6)
Motor Vehicle Accidents	4	8.0	50.2	(13.7, 128.7)
All Other Accidents	6	5.7	104.6	(38.4, 227.6)
Suicides	2	5.2	38.6	(4.7, 139.4)

Table 20: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	2	3.3	60.2	(7.3, 217.6)
Residual Causes*	4	7.7	52.0	(14.2, 133.1)

* all other causes of death combined

Eleven deaths were observed for men only employed in film department(s) (Table 21). Two statistically significant SMRs occurred for this subgroup. The all cause SMR was 41.4 (95% CI = 20.7, 74.0) and the external causes SMR was 37.3 (95% CI = 10.2, 95.6). Nonsignificant decreases were observed for all cancer (SMR = 46.9; 95% CI = 5.7, 169.5) and heart disease (SMR 96.3; 95% CI = 31.3, 224.8).

Table 21: Cause-Specific SMRs for Men Only Employed in Film Department(s) Using the U.S. as Comparison Population (n = 547)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	11	26.6	41.4	(20.7, 74.0)
All Malignant Neoplasms	2	4.3	46.9	(5.7, 169.5)
Cancer of Buccal Cavity and Pharynx	0	0.1	—	(0.0, 3,497.2)
Cancer of Digestive Organs and Peritoneum	0	0.8	—	(0.0, 438.8)
Cancer of Esophagus	0	0.1	—	(0.0, 4,205.1)
Cancer of Stomach	0	0.1	—	(0.0, 2,802.6)
Cancer of Large Intestine	0	0.3	—	(0.0, 1,223.0)
Cancer of Rectum	0	0.1	—	(0.0, 5,730.7)
Cancer of Liver and Biliary Passages	0	0.1	—	(0.0, 4,808.4)
Cancer of Pancreas	0	0.2	—	(0.0, 2,170.9)
Cancer of All Other Digestive Organs	0	0.0	—	(0.0, 11,962.2)
Cancer of Respiratory System	0	1.3	—	(0.0, 294.3)
Cancer of Larynx	0	0.0	—	(0.0, 10,015.1)
Cancer of Bronchus, Trachea, and Lung	0	1.2	—	(0.0, 310.2)
Cancer of Other Respiratory Organs	0	0.0	—	(0.0, 13,379.9)
Cancer of Prostate	0	0.1	—	0.0, 7,688.6)
Cancer of Testes and Other Male Genital Organs	0	0.1	—	(0.0, 3,598.5)
Cancer of Kidney	0	0.1	—	(0.0, 3,050.4)
Cancer of Bladder and Other Urinary Organs	0	0.0	—	(0.0, 9,158.4)

Table 21: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	0	0.3	---	(0.0, 1,233.1)
Cancer of Thyroid and Other Endocrine Glands	0	0.0	---	(0.0, 15,776.9)
Cancer of Bone	0	0.0	---	(0.0, 10,720.6)
Cancer of All Lymphatic and Hematopoietic Tissue	1	0.7	137.1	(3.4, 763.8)
Lymphoma	0	0.1	---	(0.0, 4,372.5)
Hodgkin's Disease	0	0.1	---	(0.0, 2,803.9)
Leukemia and Aleukemia	0	0.3	---	(0.0, 1,260.7)
Cancer of Other Lymphatic and Hematopoietic Tissue	1	0.2	452.3	(11.3, 2,520.4)
Malignant Melanoma of Skin	1	0.2	427.6	(10.7, 2,382.5)
All Other Malignant Neoplasms	0	0.4	---	(0.0, 920.0)
Diabetes Mellitus	0	0.4	---	(0.0, 1,056.3)
Cerebrovascular Disease	0	0.6	---	(0.0, 642.5)
All Heart Disease	5	5.2	96.3	(31.3, 224.8)
Hypertension	0	0.0	---	(0.0, 14,566.9)
Respiratory Disease	0	0.7	---	(0.0, 509.5)
Ulcer of Stomach and Duodenum	0	0.1	---	(0.0, 7,745.3)
Cirrhosis of Liver	0	1.0	---	(0.0, 385.9)
Nephritis and Nephrosis	0	0.1	---	(0.0, 4,857.8)
External Causes	4	10.7	37.3	(10.2, 95.6)
Accidents	3	6.6	45.8	(9.5, 133.9)
Motor Vehicle Accidents	1	3.8	26.1	(0.7, 145.4)
All Other Accidents	2	2.7	73.3	(8.9, 264.8)
Suicides	0	2.5	---	(0.0, 147.2)

Table 21: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	1	1.6	60.9	(1.5, 339.6)

Discussion

A retrospective cohort mortality study was conducted of former and current employees who had worked at least one year at the 3M Plant in Decatur, Alabama and at least one day after March 1, 1961. Vital status was determined through the end of 1991.

Male and female employees had less than the expected number of deaths from all causes. For men, this decrease was statistically significant. Similar results were seen for the subgroups of men defined by department(s) worked. For each of the subgroups, the overall number of deaths was less than expected.

There were a total of 4 deaths among women and 3 of these deaths were due to external causes resulting in a nonsignificant two-fold increase in risk. Examination of the death certificates for those women with external causes of death revealed that the excess mortality was not work-related.

Follow-up of the cohort and ascertainment of causes of death for deceased cohort members was virtually complete. Vital status was determined for 1,951 (99.7%) of the 1,957 cohort members. Of the 74 deceased employees, death certificates were obtained for 72 (97.3%). Quality control measures were implemented throughout the study to ensure the integrity of the data. In addition, several comparison populations were defined and the results were compared and found to be similar.

3M provided the information used to assemble the cohort. Although every effort was made to ensure that the cohort was complete, there was no way to independently verify the completeness of the cohort. In an attempt to assess whether the cohort was complete, 3M was asked to supply year-end counts of employees at the 3M Decatur Plant for each year during the study period (i.e., 1961 - 1991). These counts were compared to the counts of employees working at the 3M Decatur Plant in December of each year as determined from the study database. The counts from the study database were nearly the same as, or usually greater than, those reported by 3M.

Recommendation

It is recommended that the mortality experience of this group of employees be updated in 1998. At that time, the NDI will have death records available for an additional five years, 1992 - 1996. Analyses with additional years of follow-up and deaths would allow examination of whether the mortality profile is consistent over time.

to ~~update in Sep. [illegible] through 1994~~
~~[illegible] may be better to do in 1995~~?

<u>References</u>

1. Marsh GM, Preininger M. OCMAP: A user-oriented occupational cohort mortality analysis program. Amer Stat 1980;34:245.

2. Monson RR. Analysis of relative survival and proportional mortality. Comput Biomed Res 1974;7:325-332.

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References

1. Marsh GM, Preininger M. OCMAP: A user-oriented occupational cohort mortality analysis program. Amer Stat 1980;34:245.

2. Monson RR. Analysis of relative survival and proportional mortality. Comput Biomed Res 1974;7:325-332.

Table 22: Cause-Specific SMRs for Men Using Alabama as Comparison Population (n = 1,639)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	70	127.7	54.8	(42.7, 69.3)
All Malignant Neoplasms	15	24.6	60.9	(34.1, 100.4)
Cancer of Buccal Cavity and Pharynx	0	0.6	—	(0.0, 649.5)
Cancer of Digestive Organs and Peritoneum	1	4.3	23.1	(0.6, 128.8)
Cancer of Esophagus	0	0.5	—	(0.0, 810.9)
Cancer of Stomach	0	0.6	—	(0.0, 662.4)
Cancer of Large Intestine	1	1.6	63.8	(1.6, 355.5)
Cancer of Rectum	0	0.3	—	(0.0, 1,290.0)
Cancer of Liver and Biliary Passages	0	0.5	—	(0.0, 779.9)
Cancer of Pancreas	0	1.0	—	(0.0, 381.1)
Cancer of All Other Digestive Organs	0	0.1	—	(0.0, 2,904.8)
Cancer of Respiratory System	7	9.9	70.9	(28.5, 146.1)
Cancer of Larynx	0	0.2	—	(0.0, 1,651.8)
Cancer of Bronchus, Trachea, and Lung	7	9.5	73.4	(29.5, 151.3)
Cancer of Other Respiratory Organs	0	0.1	—	(0.0, 3,160.3)
Cancer of Prostate	0	0.5	—	(0.0, 728.3)
Cancer of Testes and Other Male Genital Organs	0	0.3	—	(0.0, 1,309.5)
Cancer of Kidney	0	0.6	—	(0.0, 657.5)
Cancer of Bladder and Other Urinary Organs	1	0.2	419.9	(10.5, 2,339.6)

Table 22: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	1	1.4	70.7	(1.8, 393.8)
Cancer of Thyroid and Other Endocrine Glands	0	0.1	---	(0.0, 3,017.6)
Cancer of Bone	0	0.1	—	(0.0, 3,406.6)
Cancer of All Lymphatic and Hematopoietic Tissue	3	2.9	104.4	(21.5, 305.0)
Lymphoma	0	0.4	—	(0.0, 987.9)
Hodgkin's Disease	0	0.4	—	(0.0, 1,018.5)
Leukemia and Aleukemia	1	1.2	84.6	(2.1, 471.6)
Cancer of Other Lymphatic and Hematopoietic Tissue	2	1.0	208.7	(25.3, 754.0)
Malignant Melanoma of Skin	1	1.1	95.2	(2.4, 530.3)
All Other Malignant Neoplasms	1	2.6	38.9	(1.0, 216.7)
Diabetes Mellitus	0	1.4	—	(0.0, 259.0)
Cerebrovascular Disease	1	3.6	27.8	(0.7, 155.2)
All Heart Disease	17	32.0	53.2	(31.0, 85.1)
Hypertension	0	0.2	—	(0.0, 2,007.5)
Respiratory Disease	0	4.6	—	(0.0, 80.2)
Ulcer of Stomach and Duodenum	0	0.3	—	(0.0, 1,256.6)
Cirrhosis of Liver	3	3.4	88.9	(18.3, 259.7)
Nephritis and Nephrosis	0	0.4	—	(0.0, 917.2)
External Causes	25	42.4	59.0	(38.2, 87.1)
Accidents	19	28.2	67.3	(40.5, 105.1)
Motor Vehicle Accidents	9	17.1	52.7	(24.1, 100.0)
All Other Accidents	10	11.2	89.3	(42.8, 164.2)
Suicides	4	7.8	51.3	(14.0, 131.5)

Table 22: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	2	6.1	32.6	(3.9, 117.9)
Residual Causes*	7	13.8	50.6	(20.3, 104.2)
Unknown Causes†	2			

* all other causes of death combined
† no death certificate obtained; included only in all causes of death category

Table 23: Cause-Specific SMRs for Women Using Alabama as Comparison Population (n = 318)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	4	6.7	59.9	(16.3, 153.4)
All Malignant Neoplasms	0	2.3	—	(0.0, 162.5)
Cerebrovascular Disease	1	0.3	357.1	(8.9, 1,989.6)
All Heart Disease	0	1.0	—	(0.0, 372.0)
Respiratory Disease	0	0.3	—	(0.0, 1,391.2)
External Causes	3	1.7	179.5	(37.0, 524.7)
Accidents	2	1.1	185.8	(22.5, 671.2)
Motor Vehicle Accidents	2	0.8	251.1	(30.4, 907.2)
All Other Accidents	0	0.3	—	(0.0, 1,323.4)
Suicides	0	0.3	—	(0.0, 1,096.1)
Homicides and Other External Causes	1	0.3	392.8	(9.8, 2,188.8)

Table 24: Cause-Specific SMRs for Men Using the Alabama Counties as Comparison Population (n = 1,639)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	70	134.7	52.0	(40.5, 65.7)
All Malignant Neoplasms	15	25.1	59.9	(33.5, 98.8)
Cancer of Buccal Cavity and Pharynx	0	0.5	—	(0.0, 822.6)
Cancer of Digestive Organs and Peritoneum	1	4.2	23.7	(0.6, 132.3)
Cancer of Esophagus	0	0.4	—	(0.0, 1,048.0)
Cancer of Stomach	0	0.5	—	(0.0, 679.5)
Cancer of Large Intestine	1	1.5	64.8	(1.6, 361.3)
Cancer of Rectum	0	0.3	—	(0.0, 1,491.0)
Cancer of Liver and Biliary Passages	0	0.5	—	(0.0, 721.6)
Cancer of Pancreas	0	1.0	—	(0.0, 374.8)
Cancer of All Other Digestive Organs	0	0.1	—	(0.0, 2,730.1)
Cancer of Respiratory System	7	10.2	69.0	(27.7, 142.1)
Cancer of Larynx	0	0.2	—	(0.0, 1,623.4)
Cancer of Bronchus, Trachea, and Lung	7	9.8	71.3	(28.7, 146.9)
Cancer of Other Respiratory Organs	0	0.1	—	(0.0, 3,493.0)
Cancer of Prostate	0	0.5	—	(0.0, 711.6)
Cancer of Testes and Other Male Genital Organs	0	0.3	—	(0.0, 1,409.3)
Cancer of Kidney	0	0.6	—	(0.0, 671.1)
Cancer of Bladder and Other Urinary Organs	1	0.3	358.7	(9.0, 1,998.9)

Table 24: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Cancer of Brain and Other Central Nervous System	1	1.3	78.0	(2.0, 434.7)
Cancer of Thyroid and Other Endocrine Glands	0	0.1	---	(0.0, 2,981.2)
Cancer of Bone	0	0.1	---	(0.0, 2,711.5)
Cancer of All Lymphatic and Hematopoietic Tissue	3	2.9	102.8	(21.2, 300.5)
Lymphoma	0	0.3	---	(0.0, 1,194.5)
Hodgkin's Disease	0	0.4	---	(0.0, 1,021.6)
Leukemia and Aleukemia	1	1.2	81.6	(2.0, 454.9)
Cancer of Other Lymphatic and Hematopoietic Tissue	2	1.0	195.5	(23.7. 706.1)
Malignant Melanoma of Skin	1	1.0	100.4	(2.5, 559.5)
All Other Malignant Neoplasms	1	3.0	33.0	(0.8, 183.9)
Diabetes Mellitus	0	1.3	---	(0.0, 275.4)
Cerebrovascular Disease	1	3.8	26.5	(0.7, 147.5)
All Heart Disease	17	34.6	49.1	(28.6, 78.6)
Hypertension	0	0.1	---	(0.0, 2,762.4)
Respiratory Disease	0	5.0	---	(0.0, 73.9)
Ulcer of Stomach and Duodenum	0	0.3	---	(0.0, 1,212.4)
Cirrhosis of Liver	3	3.2	92.8	(19.2, 271.3)
Nephritis and Nephrosis	0	0.4	---	(0.0, 925.1)
External Causes	25	45.4	55.0	(35.6, 81.3)
Accidents	19	31.2	60.9	(36.7, 95.1)
Motor Vehicle Accidents	9	19.4	46.5	(21.2, 88.2)
All Other Accidents	10	11.9	84.2	(40.4, 154.8)
Suicides	4	7.5	53.3	(14.5, 136.5)

Table 24: (Continued)				
Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Homicides and Other External Causes	2	6.5	30.9	(3.7, 111.8)
Residual Causes*	7	14.4	48.7	(19.6, 100.4)
Unknown Causes†	2			

* all other causes of death combined

† no death certificate obtained; included only in all causes of death category

Table 25: Cause-Specific SMRs for Women Using Alabama Counties as Comparison Population (n = 318)

Cause of Death	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
All Causes of Death	4	6.8	58.6	(16.0, 150.1)
All Malignant Neoplasms	0	2.3	—	(0.0, 162.4)
Cerebrovascular Disease	1	0.3	320.2	(8.0, 1,784.0)
All Heart Disease	0	1.1	—	(0.0, 343.9)
Respiratory Disease	0	0.3	—	(0.0, 1,381.0)
External Causes	3	1.7	172.1	(35.5, 502.9)
Accidents	2	1.2	173.1	(20.9, 625.3)
Motor Vehicle Accidents	2	0.9	230.5	(27.9, 832.6)
All Other Accidents	0	0.3	—	(0.0, 1,289.2)
Suicides	0	0.3	—	(0.0, 1,142.5)
Homicides and Other External Causes	1	0.3	382.1	(9.6, 2,129.3)