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Mortality Among Rubber Workers: VIII. Industrial Products Workers

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This report compares the mortality experience of 6,533 men employed in the industrial products division of a rubber manufacturing company with that of U.S. males and of other rubber workers. For most causes of death the mortality rates of industrial products workers were lower than those of U.S. males and similar to those of other rubber workers. Relative to other rubber workers, men in the industrial products division had a 50% excess of deaths from lymphoma, a 90% excess of deaths from multiple myeloma, and a 20% excess of deaths from bladder cancer during the study period. The excesses of lymphoma and multiple myeloma were strongest during recent follow-up in 1970–78 (observed/expected deaths: 10/4.3 for lymphoma; 10/4.4 for multiple myeloma), whereas bladder cancer mortality was not excessive during this calendar period.

Key words: rubber workers, mortality, multiple myeloma, lymphoma, bladder cancer

INTRODUCTION

In a recent study of men employed at a large rubber manufacturing company we found an elevated rate of mortality from lymphomas and multiple myeloma [Delzell and Monson, 1981]. The excess of deaths from these malignancies appeared to concentrate among men who had worked either in the rubber reclaim division or in hose and belt manufacturing in the industrial products division of the company. In this report we describe cause-specific mortality among workers in industrial products and present further details of the association between employment in this division and death from lymphomas and multiple myeloma.

METHODS

Enumeration and follow-up procedures for the cohort of rubber workers have been described in earlier publications [Delzell and Monson, 1981; Monson and Nakano, 1976]. All members of the cohort worked for at least 2 years before 7/1/71 at a single rubber manufacturing facility. The present report includes the experience

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of the 15,643 white male production workers who were members of the United Rubber, Cork, Linoleum and Plastic Workers of America Union and who were actively employed for some period during 1/1/40 to 7/1/70. Among these men, 6,533 had been employed in departments in the industrial products division where a wide variety of rubber goods were manufactured. Although 4,099 of the men in industrial products had worked in hose and belt making, most had been employed in other operations as well, including the manufacturing of items such as golf balls, rubber bands, and molded rubber products. Detailed information on the employment histories of industrial products workers and of men employed in other divisions was obtained from company and union records. Available data included dates of starting and terminating employment with the company and, since the mid-1930s, sequential department changes and the approximate date of each change.

Deaths that occurred between 1/1/40 and 7/1/78 among industrial products and other rubber workers were identified from company records of active and pensioned employees and from a Social Security Administration search for death claims. There were 2,270 deaths among industrial products workers and 4,527 deaths among other employees reported during the study period. Death certificates were obtained for 95% and 96% of the reported deaths among industrial products and other workers, respectively. The underlying cause of death was coded according to the International Classification of Diseases (ICD), Seventh Revision, using the ICD rules in effect in the year of death. Death certificates were coded without reference to decedents' work histories. When a death certificate could not be located, the decedent was assumed to have died of an unknown cause on the date reported.

Observed numbers of deaths among industrial products workers were compared with numbers expected based on the mortality rates of either U.S. white males or other rubber workers who were not employed in industrial products. Expected numbers were calculated by grouping the person-years of observation of industrial products workers into 5-year age and calendar period categories and multiplying by the corresponding cause-specific rates of U.S. white males or other rubber workers [Monson, 1974]. For industrial products workers, the observation period started on 1/1/40 or the midyear of starting work in the division, whichever was later. All men who had ever worked in the industrial products division contributed person-years to this category. For other rubber workers, accumulation of person-years began in the second year after starting work at the company or on 1/1/40, whichever was later. Rate ratios were estimated as ratios of observed to expected numbers of deaths (O/E). For comparisons with U.S. males, confidence intervals of the O/E were estimated assuming a Poisson distribution of the observed number of deaths. Because many of the industrial products workers had been employed in a number of different departments and operations in the division, most analyses focused on the overall cohort of industrial products workers, rather than on the experience of men in specific departments.

RESULTS

Characteristics of industrial products and other rubber workers are shown in Table I. Industrial products workers tended to have begun working at the company later and were consequently slightly younger as a group than other men. Men over

TABLE I. Selected Characteristics of Industrial Products Workers and Other Rubber Workers

Characteristics	Industrial products	Other[a]
Number of employees	6,533	9,110
Person-years of observation	182,702	265,164
Average year started at the company	1940	1935
Number started at the plant after 1939	3,922 (60%)	4,141 (46%)
Average number of years worked at the company	22	21
Average year started in industrial products	1943	—
Average number of years worked in industrial products	9.0	—

[a]Men never employed in industrial products.

64 years of age contributed approximately 12% and 17% of the total observation time of industrial products workers and other workers, respectively.

The mortality experience of industrial products workers is compared with that of U.S. white males in Table II. There were fewer deaths than expected from all major causes other than diseases of the nervous system. With the exception of malignant neoplasms, these deficits were substantial and ranged from a 20% deficit of deaths from all causes combined, diabetes, and circulatory and digestive diseases to a 40% deficit of deaths from diseases of the genitourinary system and from external causes. There was an excess of deaths from other lymphoma and multiple myeloma. In this category, seven of the observed deaths were from other lymphoma (ICD code 202), and 11 were from multiple myeloma (ICD code 203). There was also a 30% excess of bladder cancer deaths; however, this result was statistically unstable.

Comparisons of the age- and calendar period-adjusted mortality rates of industrial products and other rubber workers indicated that they had similar rates of mortality from all causes combined, as well as from circulatory, respiratory, and digestive diseases (Table III). There was a slight excess of genitourinary diseases and a deficit of deaths from external causes among men employed in industrial products. The multiple myeloma rate was 90% higher among industrial products than among other workers, and the rate of lymphosarcoma, reticulosarcoma, and other lymphoma was also elevated. The bladder cancer rate was 20% higher among industrial products workers.

Previous studies of this cohort of rubber workers found associations between bladder cancer, lymphoma, and multiple myeloma and employment in the following departments and divisions other than industrial products [Delzell and Monson, 1981; Monson and Fine, 1978]: chemicals and warehousing (bladder cancer), tire building (bladder cancer, lymphoma), and rubber reclaiming (multiple myeloma). However, analyses that excluded men who had been employed in these departments also found excesses of these three malignancies among industrial products workers compared to other rubber workers. In these analyses, O/E were 1.3 (15 observed/11.5 expected) for bladder cancer, 1.4 (14 observed/10.3 expected) for lymphoma, and 1.8 (8 observed/4.4 expected) for multiple myeloma.

TABLE II. Observed and Expected[a] Numbers of Deaths Among Industrial Products Workers According to Cause

Cause of death (ICD No.)[b]	Observed	Expected	O/E[c]	95% CI[d]
All causes	2,270	2,680.3	0.8	0.8–0.9
Malignant neoplasms (140–205)	454	505.0	0.9	0.8–1.0
Buccal cavity and pharynx (140–149)	16	16.7	1.0	0.6–1.6
Digestive organs and peritoneum (150–159)	138	154.2	0.9	0.8–1.1
Esophagus (150)	10	12.2	0.8	0.4–1.5
Stomach (151)	30	33.0	0.9	0.6–1.3
Large intestine and rectum (153, 154)	61	65.4	0.9	0.7–1.2
Pancreas (157)	23	28.4	0.8	0.5–1.2
Lung (162, 163)	123	149.9	0.8	0.7–1.0
Prostate (177)	39	36.1	1.1	0.8–1.5
Kidney (180)	10	12.4	0.8	0.4–1.5
Bladder (181)	21	16.8	1.3	0.8–1.9
Lymphosarcoma and reticulosarcoma (200)[e]	11	10.5	1.0	0.5–1.9
Leukemia (204)	22	20.0	1.1	0.7–1.7
Other lymphoma and multiple myeloma (202, 203, 205)[e]	18	10.4	1.7	1.0–2.7
Diabetes mellitus (260)	33	38.7	0.8	0.6–1.2
Diseases of the nervous system (330–398)	218	223.2	1.0	0.8–1.1
Diseases of the circulatory system (400–468)	1,025	1,237.2	0.8	0.8–0.9
Diseases of the respiratory system (470–527)	109	152.4	0.7	0.6–0.9
Diseases of the digestive system (530–587)	97	127.8	0.8	0.6–0.9
Diseases of the genitourinary system (590–637)	29	46.2	0.6	0.4–0.9
External causes (800–998)	125	219.8	0.6	0.5–0.7
Other known causes	70	118.7	0.6	—
Unknown causes	110			

[a]Expected numbers are based on age- and calendar time-specific mortality rates of U.S. white males.
[b]International Classification of Diseases, 7th Revision.
[c]Observed/expected number of deaths.
[d]Confidence interval of the O/E.
[e]Deaths before 1950 are not included for codes 200, 202, and 203.

Table IV shows further details of mortality from bladder cancer, lymphoma, and multiple myeloma among industrial products workers. The excesses of bladder cancer and of multiple myeloma occurred only among men under 65 years of age, whereas the lymphoma excess predominated among men who were 65 and older. There was no excess of lymphoma or multiple myeloma before 1970, whereas the bladder cancer excess occurred only during the period of 1940–69. Bladder cancer and multiple myeloma were elevated primarily among men who started working in industrial products in 1935–44. In contrast, excess lymphoma was apparent only among men who began working in the division after 1944. The excesses of bladder cancer and lymphoma concentrated in men who worked for less than 5 years in industrial products and who died within 20 years of beginning work in the division. A different pattern was seen for multiple myeloma mortality, which was increased only among men who worked for at least 5 years in industrial products. In addition, the excess of deaths from multiple myeloma was not present until at least 20 years after the date of first employment in the division. The patterns found for each of these malignancies were unchanged in analyses that excluded men employed in other high-risk areas of the company.

TABLE III. Mortality Rates[a] For Selected Causes Among Industrial Products and Other Rubber Workers

Cause of death	Industrial products		Other		Rate ratio
	Rate	N[b]	Rate	N	
All causes	12.4	2,270	12.8	4,527	1.0
Malignant neoplasms	2.5	454	2.7	898	0.9
Digestive organs and peritoneum	0.76	138	0.92	336	0.8
Lung	0.67	123	0.74	219	0.9
Bladder	0.11	21	0.09	39	1.2
Lymphoma[c]	0.10	18	0.06	19	1.5
Multiple myeloma	0.06	11	0.03	12	1.9
Circulatory diseases	5.6	1,025	5.7	2,085	1.0
Respiratory diseases	0.60	109	0.61	219	1.0
Digestive diseases	0.53	97	0.57	197	0.9
Genitourinary disease	0.16	29	0.14	63	1.2
External causes	0.68	125	0.80	235	0.8

[a]Rate × 1,000 person-years of observation, adjusted for age and calendar period using the person-years distribution of workers employed in industrial products.
[b]Number of deaths.
[c]Includes lymphosarcoma, reticulosarcoma, and other lymphoma.

TABLE IV. Observed/Expected[a] Deaths From Bladder Cancer, Lymphoma, and Multiple Myeloma Among Industrial Products Workers According to Selected Characteristics

Characteristic	Bladder cancer	Lymphoma	Multiple myeloma
Age at death (yrs)			
<65	9/ 4.3	9/7.3	7/1.8
≥65	12/12.8	9/4.6	4/4.1
Year of death			
<1970[b]	13/ 7.1	8/7.6	1/1.5
1970–78	8/10.0	10/4.3	10/4.4
Year started work in industrial products			
<1935	8/ 7.8	5/4.6	3/2.3
1935–44	9/ 5.0	3/4.1	6/1.7
≥1945	4/ 4.3	10/3.2	2/1.9
Duration of employment in industrial products			
<5 years	8/ 5.6	10/4.3	3/2.2
≥5 years	13/11.5	8/7.6	8/3.7
Years since starting work in industrial products			
<5	1/ 0.3	1/0.3	0/0.1
5–19	6/ 3.0	7/2.5	1/0.8
≥20	14/13.8	10/9.1	10/5.0

[a]Expected numbers are based on the cause-, age- and calendar period-specific rates of other rubber workers.
[b]This category includes the period of 1940-69 for bladder cancer and 1950-69 for lymphoma and multiple myeloma.

Analysis of cause-specific mortality by section of the industrial products division showed that the lymphoma excess occurred predominantly among men who were ever employed in miscellaneous industrial products (10 observed/5.7 expected), whereas multiple myeloma was elevated primarily among men who had ever worked in hose and belt production (8 observed/3.2 expected). Bladder cancer did not appear to be particularly increased in any of the major sections of the industrial products division.

DISCUSSION

In this study we evaluated the mortality experience of rubber workers employed in the manufacture of industrial products. These men had rates of overall mortality and of mortality from most major causes of death that were similar to those of other rubber workers at the company under study. However, men who worked in industrial products had higher rates of several malignant neoplasms, including bladder cancer, lymphoma, and multiple myeloma. The observed excesses among industrial products workers could not be explained entirely by earlier or later employment in other production areas that were independently associated with these three malignancies.

Detailed analyses of mortality from bladder cancer indicated that the rate was elevated only among men who started working in industrial products during 1935–44 and that all of the excess mortality occurred within 20 years of beginning work in the division. If the relationship between bladder cancer and work in industrial products is causal, these findings would suggest that any bladder carcinogen that might have been present in the division was removed in the mid-1940s. However, the relatively short induction period indicated by our analyses, the lack of any effect of duration of employment, and the rather moderate excess of bladder cancer deaths imply that the observed association may not be causal.

The patterns for lymphoma indicated an increased rate only among men who began working in industrial products after 1944. The data for multiple myeloma were not adequate for evaluating the experience of this category of workers. This observation is consistent with analyses of multiple myeloma by years since starting work, which suggested an induction period of at least 20 years. The excesses found for both multiple myeloma and lymphoma were actually strongest in the most recent follow-up period. In contrast to the duration of employment pattern found for multiple myeloma, the excess risk of lymphoma concentrated among men who worked in industrial products for under 5 years, rather than among longer-term workers as might be expected if there is a causal association between lymphoma and work in industrial products. Therefore, although it is not possible to state conclusively that the associations found for lymphoma and multiple myeloma in this study are causal, it should be recognized that men with a history of employment in this division may still have an increased risk of developing these two malignancies.

A previous report of mortality in another group of rubber workers noted an excess of deaths from stomach cancer and ischemic heart disease among men employed in certain operations in the industrial products division of the plant studied [Andjelkovich et al, 1977]. This investigation did not find any statistically significant excess of deaths from bladder cancer, lymphoma, or multiple myeloma among men who had worked longer in industrial products than in other areas of the plant. Also, our study does not confirm the positive findings of the earlier report.

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