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Mortality Among Rubber Workers: X. Reclaim Workers

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This study evaluated the mortality experience of 1,352 white and 438 nonwhite men who worked in the rubber-reclaiming division of a large rubber manufacturing company. In comparisons of mortality of white reclaim workers with that of nonreclaim workers rate ratios were 2.7 for esophageal cancer (six observed deaths among reclaim workers), 2.1 for bladder cancer (seven observed deaths), and 4.5 for multiple myeloma (six observed deaths). The excess of bladder cancer among white reclaim workers may be associated with their employment in other high-risk areas of the plant, whereas no such explanation was found for the excesses of esophageal cancer and multiple myeloma. Overall, the lung cancer mortality rate of white reclaim workers was similar to the rate of US white males and other white rubber workers. There was a 50% excess of lung cancer deaths among nonwhite reclaim workers compared with other nonwhite rubber workers. However, this observation is based on small numbers, and no firm conclusions can be reached about the risk of lung cancer associated with reclaim operations in this group of rubber workers.

Key words: occupational diseases, epidemiology, neoplasms

INTRODUCTION

Studies of two groups of workers in the rubber manufacturing industry found increased mortality from lung cancer among men employed in reclaim operations [McMichael et al, 1976; Delzell et al, 1982]. A recent study of mortality in a third large group of rubber workers noted excesses of deaths from esophageal cancer and from multiple myeloma among white male union members who worked in rubber reclaiming [Delzell and Monson, 1981]. The present study of these employees describes further details of the cause-specific mortality of both white and nonwhite male reclaim workers.

METHODS

The group of rubber workers under study and the procedures used to determine their mortality experience have been described in detail elsewhere [Delzell and Monson, 1981; Monson and Nakano, 1976]. All workers were employed for at least

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two years before 7/1/71 at a single rubber manufacturing facility. The 15,643 white males and 1,184 nonwhite males who were actively employed at some point during the period 1/1/40–7/1/71 and who were members of the United Rubber, Cork, Linoleum, and Plastic Workers of America Union are included in the present report. Among these men, there were 1,352 white and 438 nonwhite workers who had been employed in the reclaim division and who are referred to as "reclaim workers" in this report. Details of their employment history, which were obtained from company and union records, 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.

The reclaim division at the plant handled both natural and synthetic rubbers. Reclaiming operations consisted of preparing scrap rubber for reclaiming, followed by grinding and devulcanizing under heat and pressure. Devulcanized rubber was pumped across screens, washed, press-dried, and remilled. Rubber reclaiming ended at the plant in 1972.

Deaths occurring among reclaim and other production workers during 1/1/40–7/1/78 were ascertained from company records of active and pensioned personnel and from a Social Security Administration search for death claims. During the study period, there were 441 and 98 deaths reported among white and nonwhite male reclaim workers, respectively. Among nonreclaim workers there were 6,356 deaths among white males and 225 deaths among nonwhite males. Death certificates were located for 96% of all the decedents. Underlying cause of death was coded according to the International Classification of Diseases, Seventh Revision, without reference to decedents' work histories. Reported decedents without death certificate confirmation were assumed to have died of unknown causes on the date reported.

Overall and cause-specific numbers of deaths observed among reclaim workers were compared with numbers expected based on the mortality rates of either US males or nonreclaim workers. For both types of comparison, expected numbers were computed by grouping the person-years of observation of reclaim workers into five-year age and calendar time intervals and applying the corresponding race-specific national or nonreclaim rates [Monson, 1974]. For reclaim workers, accumulation of person-years of observation started on 1/1/40 or the midyear of starting work in the division, whichever was later. For nonreclaim workers, person-year accrual started on 1/1/40 or the second anniversary after starting work at the company, whichever was later. Rate ratios were estimated as ratios of observed to expected numbers of deaths (O/E). Confidence intervals of the O/E and p-values were estimated assuming a Poisson distribution of the observed frequency of deaths [Rothman and Boice, 1979]. Results are presented separately for white and nonwhite males.

RESULTS

Characteristics of reclaim and nonreclaim workers are shown in Table I. White reclaim workers tended to have started later and to have worked longer at the company than other white production workers. For nonwhites, the average year of starting work at the plant was considerably later than that of white workers. However, the average year of entering the reclaim division was similar for white and nonwhite reclaim workers. Nonwhites tended to have spent several years more in the reclaim division than had whites.

TABLE I. Selected Characteristics of Reclaim Workers and Other Rubber Workers, According to Race

Characteristics	White		Nonwhite	
	Reclaim	Nonreclaim[a]	Reclaim	Nonreclaim[a]
No. of employees	1,351	14,292	438	746
Person-years of observation	30,889	411,854	10,580	18,697
Average year started at the company	1942	1937	1948	1949
No. started at the plant after 1939	921 (68%)	7,142 (50%)	423 (97%)	691 (93%)
Average No. of years worked at the company	23.4	21.1	21.7	17.4
Average year started in reclaim	1950	—	1951	—
Average No. of years worked in reclaim	5.4	—	8.8	—

[a]Refers to men never employed in reclaim.

A comparison of the mortality experience of white reclaim workers with that of US white males is shown in Table II. There were fewer deaths than expected from circulatory diseases and from external causes, and there was a slight excess of deaths from malignant neoplasms. There were substantial relative excesses of deaths from esophageal cancer, from bladder cancer, and from other lymphoma and multiple myeloma. For each of the latter three categories, the observed number of deaths was under ten, and the 95% confidence interval of the O/E for bladder cancer included 1.0. In the other lymphoma and multiple myeloma category, six of the seven observed deaths were attributed to multiple myeloma. Differences in the observed and expected numbers of deaths from the remaining causes, including lung cancer, were trivial.

Comparisons of the age- and calendar time-adjusted mortality rates of white reclaim and nonreclaim workers indicated that they had similar rates of mortality from circulatory diseases (rate ratio: 1.0) and from external causes (rate ratio: 1.1) (Table III). The overall lung cancer rate was only slightly higher among reclaim than among nonreclaim workers (rate ratio: 1.1). There was no excess of lung cancer among long-term employees in reclaim (observed/expected number of deaths, based on rates of white nonreclaim workers: 12/10.8 for men who spent at least five years in reclaim; 7/6.0 for men who spent at least ten years in reclaim). There was a slight increase in lung cancer among men who started working in reclaim after 1944 (observed/expected: 19/12.9), whereas there was no excess among men who started before 1945 (observed/expected: 8/11.0).

In comparisons of reclaim with nonreclaim workers the relative excesses of deaths from esophageal and bladder cancers and from multiple myeloma were similar in magnitude to those found in comparisons with US white males. The excess of esophageal cancer appeared to be larger for men who worked in reclaim for ten or more years (observed/expected: 3/0.6) than for those who spent fewer than ten years there (observed/expected: 3/1.6) and for men who started working in reclaim before 1945 (observed/expected: 4/1.0) than for men who started after 1944 (observed/expected:2/1.2). In contrast, all of the seven bladder cancer deaths occurred among men who were employed in reclaim for fewer than ten years (observed/expected: 7/2.2), and six occurred among men who started working in the division after 1945

TABLE II. Observed and Expected* Numbers of Deaths Among White Male Reclaim Workers According to Cause

Cause of death (ICD No.)[a]	Observed	Expected	O/E[b]	95% CI[c]
All causes	441	489.4	0.9	0.8–1.0
Malignant neoplasms (140–205)	102	93.2	1.1	0.9–1.3
Digestive organs and peritoneum (150–159)	36	28.2	1.3	0.9–1.8
Esophagus (150)	6	2.3	2.7	1.0–5.8
Stomach (151)	6	6.0	1.0	0.4–2.2
Large intestine (153)	9	8.7	1.0	0.5–2.0
Pancreas (157)	7	5.3	1.3	0.5–2.7
Lung (162, 163)	27	28.0	1.0	0.6–1.4
Prostate (177)	6	6.8	0.9	0.3–1.9
Kidney (180)	3	2.3	1.3	0.3–3.8
Bladder (181)	7	3.1	2.3	0.9–4.6
Leukemia (204)	3	3.6	0.8	0.2–2.4
Other lymphoma and multiple myeloma (202, 203, 205)[d]	7	2.0	3.6	1.4–7.4
Diabetes mellitus (260)	8	7.1	1.1	0.5–2.2
Vascular lesions of the central nervous system (330–334)	35	37.7	0.9	0.7–1.3
Diseases of the circulatory system (400–468)	188	228.6	0.8	0.7–1.0
Diseases of the respiratory system (470–527)	25	28.2	0.9	0.6–1.3
Emphysema (527)	10	7.8	1.3	0.6–2.4
Diseases of the digestive system (530–587)	21	23.0	0.9	0.6–1.4
Diseases of the genito-urinary system (590–637)	6	8.1	0.7	0.3–1.6
External causes (800–998)	26	37.5	0.7	0.5–1.0
Other known causes	17	18.1	0.9	—
Unknown causes	12	—	—	—

*Expected Nos. are based on age- and calendar time-specific mortality rates of US white males.
[a]International Classification of Diseases, 7th revision.
[b]Observed/expected No. of deaths.
[c]CI denotes the confidence interval of the O/E.
[d]Deaths before 1950 are not included for codes 202 and 203.

(observed/expected: 6/1.5). Therefore, it seemed possible that the bladder cancer deaths occurred predominantly among reclaim workers who had spent a substantial amount of time in other divisions at the plant. Further analysis revealed that only two of the seven reclaim workers with bladder cancer had not also worked in either the industrial products division or the chemical division. Because elevated bladder cancer mortality has been found in both of the latter two divisions, it is likely that the increased bladder cancer in reclaim workers is associated with their employment in other high-risk areas of the plant and not with exposures encountered in the reclaim division.

Results of analyses of multiple myeloma mortality according to calendar period, duration of employment, and time since starting work in reclaim were generally unremarkable. However, five of the six deaths from multiple myeloma occurred among men who were under 65 years of age (observed/expected: 5/0.6), and the excess of multiple myeloma appeared to be larger among men who started in reclaim before 1945 (observed/expected: 4/0.6) than among those who started after 1944 (observed/expected: 2/0.8). An excess of multiple myeloma has also been found in the industrial products division and in certain sections of the aerospace division of the

TABLE III. Mortality Rates From Selected Causes Among White Male Reclaim and Nonreclaim Workers

Cause of death	Rate[a]		RR[c]	P-Value
	Reclaim (N)[b]	Nonreclaim (N)		
All causes	14.3 (441)	13.9 (6356)	1.0	0.56
Malignant neoplasms	3.3 (102)	2.8 (1250)	1.2	0.14
Digestive organs and peritoneum	1.2 (36)	0.92 (438)	1.3	0.19
Esophagus	0.19 (6)	0.07 (30)	2.7	0.03
Lung	0.87 (27)	0.78 (315)	1.1	0.58
Bladder	0.23 (7)	0.11 (53)	2.1	0.10
Multiple myeloma	0.19 (6)	0.04 (17)	4.5	0.01
Circulatory diseases	6.1 (188)	6.3 (2923)	1.0	0.71
Digestive diseases	0.68 (21)	0.60 (273)	1.1	0.60
External causes	0.84 (26)	0.75 (334)	1.1	0.62

[a]Rate, ×1,000 person-years of observation, adjusted for age and calendar period using the person-years distribution of reclaim workers.
[b]N, No. of deaths.
[c]RR, rate ratio.

TABLE IV. Observed Numbers of Deaths Among Nonwhite Male Reclaim Workers According to Cause and Expected* Numbers Based on the Mortality Rates of US Black Males

Cause of death (ICD No.)	Observed	Expected	O/E	95% CI
All causes	98	167.8	0.6	0.5–0.7
Malignant neoplasms (140–205)	20	29.0	0.7	0.4–1.1
Digestive organs and peritoneum (150–159)	7	9.5	0.7	0.3–1.5
Lung (162, 163)	7	8.7	0.8	0.3–1.7
Vascular lesions of the central nervous system (330–334)	10	16.3	0.6	0.3–1.1
Diseases of the circulatory system (400–468)	42	58.1	0.7	0.5–1.0
External causes (800–998)	10	21.5	0.5	0.2–0.9
Other known causes	12	33.2	—	—
Unknown causes	4	—	—	—

*Expected Nos. are based on age- and calendar time-specific mortality rates of US black males.

plant. Reanalysis of mortality among reclaim workers, excluding all who had been employed in other high-risk areas, suggested that the elevated rate in reclaim workers persisted (observed/expected: 3/0.3).

Compared to US black males, nonwhite reclaim workers experienced substantial deficits of deaths from most causes (Table IV). Mortality from all causes combined was approximately 40% lower in nonwhite reclaim workers than in US black males, while deficits of deaths from circulatory diseases and from external causes were 30% and 50%, respectively. Comparisons of the experience of nonwhite reclaim workers with that of other nonwhite male production workers at the plant suggested that overall mortality was lower among reclaim workers (Table V). However, reclaim and nonreclaim workers had similar mortality rates for most of the specific cause of death categories shown in Table V. In addition, the age- and calendar period-adjusted overall mortality rates of nonwhite and white reclaim workers were nearly equal (nonwhites: 9.3 deaths per 1,000 person-years; whites: 10.3 deaths per 1,000 person-years). As shown in Table V, the only cause of death for which there was an elevated rate among nonwhite reclaim workers was lung cancer. This increase was not striking and was based on only seven observed deaths. Four of the lung cancer deaths occurred

TABLE V. Mortality Rates From Selected Causes Among Nonwhite Male Reclaim and Nonreclaim Workers

Cause of death (ICD No.)	Rate[a]		RR[c]	P-Value
	Reclaim (N)[b]	Nonreclaim (N)		
All causes	9.3 (98)	11.3 (225)	0.8	0.04
Malignant neoplasms (140–205)	1.9 (20)	2.3 (43)	0.8	0.42
Digestive organs and peritoneum (150–159)	0.66 (7)	0.91 (17)	0.7	0.51
Lung (162, 163)	0.66 (7)	0.44 (9)	1.5	0.40
Vascular lesions of the central nervous system (300–334)	0.95 (10)	0.88 (21)	1.1	0.89
Diseases of the circulatory system (400–468)	4.0 (42)	4.4 (90)	0.9	0.59
External causes (800–998)	0.95 (10)	0.98 (20)	1.0	0.54

[a]Rate × 1,000 person-years of observation, adjusted for age and calendar period using the person-years distribution of reclaim workers.
[b]N, No. of deaths.
[c]RR, rate ratio.

among men who had spent fewer than five years in reclaim (observed/expected: 4/1.3), whereas there was no lung cancer excess among men with five or more years of employment in reclaim (observed/expected: 3/3.4). As was observed for white reclaim workers, increased mortality from lung cancer was found for nonwhite workers who started in reclaim after 1944 (observed/expected: 6/3.4) but not for men who started in reclaim before 1945 (observed/expected: 1/1.4). There were no deaths among nonwhite reclaim workers from bladder cancer or from multiple myeloma and only one death from esophageal cancer.

DISCUSSION

This study examined the mortality experience of white and nonwhite male rubber workers employed in reclaim operations. Whereas investigations of two other groups of rubber workers reported two-fold increases in the risk of lung cancer among reclaim workers [McMichael et al, 1976; Delzell et al, 1982], the present study found no excess of deaths from lung cancer among white reclaim workers and a 50% increase among nonwhite workers. The increase among nonwhites was neither strong nor statistically stable and was confined to men who had spent fewer than five years in the reclaim division. There was a larger increase in lung cancer among nonwhites and a slight increase among whites who began working in reclaim after 1944. However, both of these increases were based on small numbers and may have occurred by chance. Overall, there is little evidence from the present study that employment in reclaim operations is strongly or causally associated with the occurrence of lung cancer. The reasons for these inconsistent findings are not clear. Exposures, work practices, and environmental controls may have differed among the plants studied. Both of the studies with positive findings evaluated lung cancer deaths occurring during 1964–1973, while the present study covered a longer time period. We also examined mortality among reclaim workers during 1965–1974 and again found no lung cancer excess for whites (observed/expected: 11/12.1). Nonwhite reclaim workers, however, had a 90% excess during 1965–1974 (observed/expected: 6/3.2). Again, the latter finding is statistically unstable because of small numbers.

The apparent excess of deaths from esophageal cancer and from multiple myeloma among white reclaim workers could not be examined in detail because of insufficient numbers. For these two cancers, ratios of observed to expected numbers of deaths were above 2.5 and were statistically stable. However, we cannot discount the possibility that unknown causal factors, distributed differently among white reclaim and nonreclaim workers, were responsible. Because the nonwhite reclaim workers comprised a much smaller group, no firm conclusions can be reached about the magnitude of their risk of these cancers. Parkes et al [1982] have reported an excess of esophageal cancer among rubber workers in the United Kingdom. The excess was present in both the tire and general rubber goods sectors of the industry. The specific groups of employees with an excess of esophageal cancer were curing workers in the general rubber goods sector and transport workers and engineering and building maintenance workers in the tire manufacturing sector. Mortality among workers in reclaim operations was not evaluated in the study by Parkes and his co-workers [1982].

In summary, the present study found no persuasive evidence of an overall association between lung cancer and reclaim work. However, because of the positive findings of two previous studies [McMichael et al, 1976; Delzell et al, 1982] and because of our finding of a slight increase among men who started working in reclaim after 1944, the possibility that certain subgroups of reclaim workers have an elevated risk of lung cancer should not be ruled out. It is likely that the increase in bladder cancer observed in the present study among white reclaim workers is associated with the earlier or later employment of these men in other high-risk areas of the plant. No similar explanation was found for the excesses of esophageal cancer and multiple myeloma.

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