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# Radiological Abnormalities and Asbestos Exposure among Custodians of the New York City Board of Education

S. M. LEVIN AND I. J. SELIKOFF

*Division of Environmental and Occupational Medicine*
*Department of Community Medicine*
*Mount Sinai School of Medicine*
*New York, New York 10029*

The exposure to asbestos and the risk of developing asbestos-related illness among custodial and maintenance workers employed in buildings with asbestos-containing materials in place are important aspects of the "third wave" of asbestos-related disease. Dr. Oliver has described the findings among custodians in the Boston schools.[1]

The custodians' union in the New York City public schools, Local 891 of the International Union of Operating Engineers, was aware that its members had been significantly exposed to asbestos in the course of their past work and had concern that they might develop asbestos-related disease. The union brought its concerns to the attention of the New York City Board of Education, which agreed that clinical evaluation of the custodians, cleaners, and firemen (who tend boiler equipment) was warranted.

The assistance of the Division of Environmental and Occupational Medicine of the Department of Community Medicine, the Mount Sinai School of Medicine, was requested. Clinical surveys were subsequently conducted at the Mount Sinai Medical Center during the period from 1985 through 1987. This investigation afforded an opportunity to obtain information on the overall prevalence of asbestos-related disease among these building custodial workers and to study in particular the health status of those who had no occupational exposure to asbestos other than in the school environment.

## MATERIALS AND METHODS

From New York City Board of Education records of current employees with known duration from onset of Board of Education employment, lists of school custodians eligible for examination were prepared by the Board, focusing primarily upon those with longest duration of Board of Education employment and currently employed by them. Seven hundred sixty-four men on the Board's list were invited by letter from the union to participate on an entirely voluntary basis. Invitees were assured of confidentiality regarding their examination results and were informed that no individual's results would be given to either the union or the Board of Education. Six hundred sixty men accepted the invitation and underwent examination, a participation rate of 86% (TABLE 1).

The examination was multifaceted, and extensive data were collected. These included demographic data (date of birth, date of first custodial work, date of first Board of Education work, history of union membership and transfer between

TABLE 1. Clinical Survey of Custodians in the New York City Public Schools, 1985–87: Worker Participation

| | Number |
|---|---|
| Workers invited | 764 |
| Examinations scheduled | 719 |
| Number examined | 660 |
| Participation rate | 660/764 = 86% |

locals); lifetime occupational histories (including history of employment in brake repair, insulation, construction, shipyard, merchant marine or other asbestos-exposed trades); history of military service; current work status, with details regarding asbestos and other occupational exposures (e.g., to PCBs, solvents); family, smoking and past medical histories; current medical history (including special focus on asbestos-related symptoms), respiratory status, dyspnea status, cardiac history, cancer history, and so forth. Laboratory tests included standard blood biochemistry studies (SMA 18), CBC with differential values, urinalysis including microscopic examination, standard spirometric studies, electrocardiogram, and PA and lateral chest radiographs (with additional views as indicated: e.g., oblique projections). All films were read at the examination site to assess quality and the need for additional views, and to identify problems requiring immediate, further evaluation. The X-ray films were re-read several weeks later by Dr. Selikoff, using the ILO-1980 Classification.[2]

## RESULTS

Two-thirds of the men examined had begun custodial work in buildings before 1965 and therefore had at least 20 or more years since onset of possible exposure to asbestos in building settings (TABLE 2). Forty-four per cent had begun work in school buildings before 1965. Twenty-four percent of those examined (for whom

TABLE 2. Year Custodial Work Was Begun

| | Any Custodial Work | | School Custodial Work | |
|---|---|---|---|---|
| Year | Number | Percent | Number | Percent |
| <1940 | 9 | 1% | 4 | 1% |
| 1940–44 | 9 | 1% | 0 | 0 |
| 1945–49 | 80 | 12% | 28 | 4% |
| 1950–54 | 66 | 10% | 48 | 7% |
| 1955–59 | 126 | 19% | 79 | 12% |
| 1960–64 | 149 | 23% | 135 | 20% |
| 1965–69 | 94 | 15% | 146 | 22% |
| 1970–74 | 99 | 15% | 151 | 23% |
| 1975–79 | 15 | 2% | 34 | 5% |
| 1980+ | 1 | <1% | 33 | 5% |
| Total | 648 | 99% | 658 | 99% |
| Missing information: | 11[a] | | 1[a] | |

[a] Not included in above totals or percentages.

TABLE 3. Other Occupational Asbestos Exposures among Custodians

| Other Exposures | | Number[a] | Percent |
|---|---|---|---|
| Brake work | Yes | 44 | 7% |
| | No | 612 | 93% |
| Insulation work | Yes | 76 | 12% |
| | No | 573 | 88% |
| Construction work | Yes | 63 | 10% |
| | No | 591 | 90% |
| Merchant Marine | Yes | 163 | 25% |
| | No | 492 | 75% |
| Shipyard | Yes | 98 | 15% |
| | No | 556 | 85% |
| Other work around asbestos | Yes | 149 | 23% |
| | No | 505 | 77% |

[a] Total responses not consistent, owing to varying availability of data for each exposure.

information was available) had begun custodial work in buildings at least 30 years earlier and were of particular interest, since what would be found among them might usefully predict the expected experience for school custodians in general.

The great majority (96%) of those examined were still working in the school system at the time of their examination, reflecting the Board of Education's selection criteria, which limited eligibility to currently employed custodians. A small number (17) had retired between the time of their enrollment and their date of examination. The population was therefore a "survivor group" who were sufficiently healthy to continue active employment.

Custodians who participated in the survey reported asbestos exposure encountered under a number of other work circumstances, as indicated in TABLE 3. One hundred twenty-nine men said they had had contact with asbestos while aboard ship during military service. In over 60% of those examined, such exposures may have contributed to the overall asbestos exposure burden. This required consideration in assessing asbestos-related disease among custodians which could be attributed to exposures encountered in the school environment alone.

As we have found in studies of other blue-collar trades, nearly three-quarters of the men examined had smoked cigarettes. Almost one-quarter continued to smoke up till the time of examination (TABLE 4). Twenty percent had smoked or

TABLE 4. Cigarette Smoking Status in Survey of New York Board of Education Custodians

| | Number | Percent |
|---|---|---|
| Current smokers | 160 | 24% |
| Ex-smokers | 320 | 49% |
| Never smoked | 179 | 27% |
| Totals | 659 | 100% |
| Missing information: 1[a] | | |

[a] Not included in totals or percentages.

TABLE 5. Asbestotic Abnormality Seen on X-ray Films in School Custodians

| X-ray Interpretation | Number | Percent |
|---|---|---|
| Normal[a] | 478 | 72% |
| Parenchymal only | 75 | 11% |
| Pleural[b] and parenchymal | 30 | 5% |
| Pleural[b] only | 77 | 12% |
| Totals | 660 | 100% |

[a] Includes profusion categorized as 0/1 and with costophrenic angle (CPA) blunting only.
[b] Includes costal and diaphragmatic plaques and diffuse pleural thickening.

were currently smoking a pipe; the comparable figure for cigars was 16%. Eight individuals reported chewing tobacco, and only one said he used snuff in the past.

## ABNORMALITIES ON X-RAY FILMS

All films were interpreted with regard to ILO-1980 categorization for parenchymal and pleural abnormalities. Virtually all films with parenchymal changes were read as ILO category 1 (1/0, 1/1, 1/2). Pleural fibrosis, again, was limited in extent (localized), with only one individual exhibiting diffuse thickening. Costophrenic angle obliteration as the sole change was not categorized as abnormal. Because of the homogeneity of the abnormalities, further analytic subclassification was not found useful.

Radiographic abnormalities consistent with asbestos-related scarring were frequently seen among the custodians examined. Overall, such changes were found in 28% of the men (TABLE 5); among men 35 years or more since onset of exposure, 39% exhibited scarring consistent with prior exposure to asbestos (TABLE 6). Because retirees were largely absent from the group examined, the great majority of the men were 40 or fewer years since onset of exposure. Among those with abnormalities, nearly equal numbers had parenchymal (lung tissue) and pleural (lining of the lung) scarring.

There was a clear relationship between the prevalence of X-ray abnormality and the years elapsed since the onset of custodial or maintenance work in buildings (TABLE 7). There were too few (only 18) individuals 40 or more years since beginning custodial work to permit reliable conclusions for those most senior; nevertheless, 11 of the 18 men (61%) in this subgroup had radiographic findings

TABLE 6. Radiographic Findings and Time since Onset of Custodial Work

| Years since Onset | X-ray Normal | | X-ray Abnormal | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| ≥35 | 60 | 61% | 38 | 39% |
| <35 | 408 | 39% | 142 | 26% |
| Total | 468 | | 180 | |
| Missing onset information: 12[a] | | | | |

[a] Not included in totals or percentages above.

TABLE 7. Frequency of X-ray Abnormality and Time since Onset of Custodial Work

| Years since Onset | X-ray Normal | | X-ray Abnormal | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| >45 | 4 | 44% | 5 | 56% |
| 40–44 | 3 | 34% | 6 | 66% |
| 35–39 | 53 | 67% | 27 | 33% |
| 30–34 | 43 | 65% | 23 | 35% |
| 25–29 | 85 | 68% | 41 | 32% |
| 20–24 | 111 | 74% | 38 | 26% |
| 15–19 | 77 | 82% | 17 | 18% |
| <15 | 92 | 80% | 23 | 20% |
| Total | 468 | 72% | 180 | 28% |
| Missing onset information: 12[a] | | | | |

[a] Not included in totals or percentages above.

consistent with asbestos-induced scarring. Of those who were 30 or more years since beginning custodial work, 37% exhibited asbestos-related abnormality on X-ray (TABLE 7).

## ASBESTOS EXPOSURE DURING SCHOOL CUSTODIAL WORK

As is evident in TABLE 8, the great majority (89%) of custodians examined reported working directly with asbestos-containing materials, by removing or fixing such materials in most cases.

In addition, most of the men examined stated that asbestos abatement projects had been carried out in the schools in which they worked. This had taken place largely in the latter 1970s and early 1980s. Where this had occurred, the majority (89%) of the custodians reported being present in the area where the work was performed, although most did not engage in the abatement activities themselves (TABLE 9).

TABLE 8. Asbestos Exposure during Custodial Work

| Nature of Exposure | Response | Number[a] | Percent |
|---|---|---|---|
| Mixed asbestos | Yes | 444 | 68% |
| | No | 190 | 29% |
| | Don't know | 15 | 2% |
| Removed asbestos | Yes | 550 | 84% |
| | No | 89 | 14% |
| | Don't know | 13 | 2% |
| Fixed asbestos | Yes | 540 | 83% |
| | No | 102 | 16% |
| | Don't know | 9 | 1% |
| Worked with asbestos[b] | Yes | 585 | 89% |
| | No/don't know | 74 | 11% |

[a] Total responses not consistent owing to varying availability of data for each exposure.
[b] Categorized as "Yes" if custodian either mixed, removed, or fixed asbestos.

TABLE 9. Asbestos Exposure during Asbestos Abatement Work in Schools

| Nature of Exposure | Response | Number[a] | Percent |
|---|---|---|---|
| Abatement work performed in school | Yes | 402 | 62% |
| | No | 251 | 38% |
| Helped during abatement job[b] | Yes | 106 | 26% |
| | No | 296 | 74% |
| Present in area during abatement[b] | Yes | 357 | 89% |
| | No | 43 | 11% |

[a] Total responses not consistent owing to varying availability of data for each exposure.
[b] Includes only those in whose schools abatement jobs were performed.

## CUSTODIANS EXPOSED TO ASBESTOS ONLY IN SCHOOL BUILDINGS

To assess the prevalence of asbestos-related disease that could be attributed to exposures encountered in the school environment, analysis of the clinical data was carried out on findings among those who had never performed custodial work in buildings other than schools and who had never worked with or around asbestos in other settings, including aboard ship. Two hundred and forty-seven men had no occupational or shipboard exposures to asbestos other than in the school setting. Their distribution by year of beginning school custodial work is presented in TABLE 10. Thirty percent had begun school employment at least 30 years earlier. Only 19 (8%) were forty or more years from beginning custodial work. Smoking histories for this subgroup were similar to what was found among the entire study population: 30% were current smokers; 43% were ex-smokers; 26% had never smoked cigarettes.

TABLE 11 shows the frequency of abnormalities seen on chest radiograph among those with only school-related exposure to asbestos; 27% exhibited asbestos-related scarring (vs. 28% for the entire study group).

Similarly, presence in the area where asbestos abatement was performed or helping with such work had no detectable influence on the prevalence of radiographic abnormality (FIG. 1); but it should be noted, however, that the removal of asbestos from the NYC schools was begun by the Board of Education only in the

TABLE 10. Asbestos Exposure Limited to New York City Board of Education Schools: Year Custodial Work Was Begun

| Year | Number | Percent |
|---|---|---|
| <1940 | 1 | <1% |
| 1940–44 | 0 | — |
| 1945–49 | 18 | 7% |
| 1950–54 | 12 | 5% |
| 1955–59 | 44 | 18% |
| 1960–64 | 58 | 23% |
| 1965–69 | 47 | 19% |
| 1970–74 | 62 | 25% |
| 1975–79 | 4 | 2% |
| 1980+ | 1 | <1% |
| Total | 247 | 100% |

**TABLE 11.** Radiographic Findings among Custodians with Exposure to Asbestos only in New York City Board of Education Schools

| X-ray Interpretation | Number | Percent |
|---|---|---|
| Normal[a] | 179 | 73% |
| Parenchymal only | 43 | 17% |
| Pleural[b] and parenchymal | 7 | 3% |
| Pleural[b] only | 18 | 7% |
| Totals | 247 | 100% |

[a] Includes profusion categorized as 0/1 and with CPA blunting only.
[b] Includes costal and diaphragmatic plaques and diffuse pleural thickening.

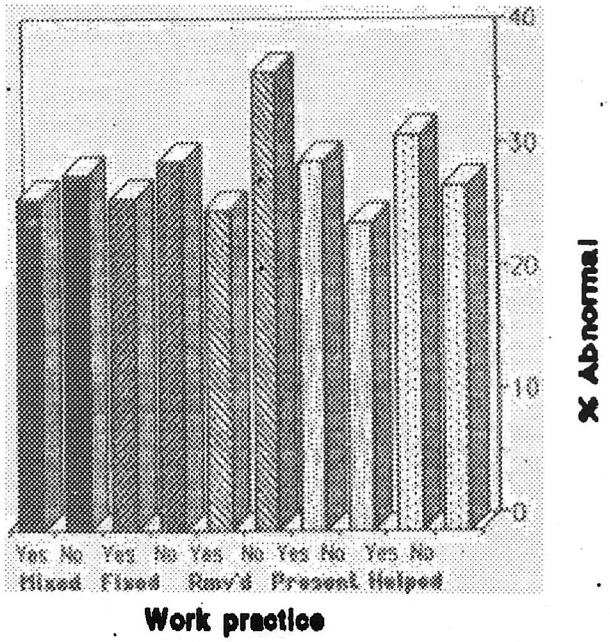



**FIGURE 1.** Influence of work practices on the prevalence of asbestotic abnormality on chest X-ray film among custodians with asbestos exposure only in New York City schools.

**TABLE 12.** Radiographic Findings and Time since Onset of Custodial Work among Custodians with Exposure to Asbestos only in New York City Board of Education Schools

| Years since Onset | X-ray Normal | | X-ray Abnormal | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| >45 | 0 | — | 1 | 100% |
| 40–44 | 0 | — | 0 | — |
| 35–39 | 9 | 50% | 9 | 50% |
| 30–34 | 9 | 75% | 3 | 25% |
| 25–29 | 26 | 59% | 18 | 41% |
| 20–24 | 42 | 72% | 16 | 28% |
| 15–19 | 40 | 85% | 7 | 15% |
| <15 | 53 | 79% | 14 | 21% |
| Total | 179 | 72% | 68 | 28% |

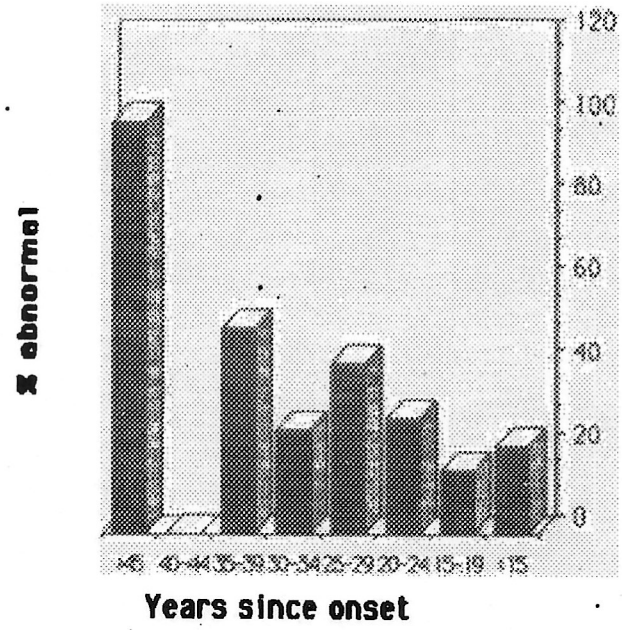



**FIGURE 2.** Radiographic findings and time since onset of custodial work among custodians with exposure to asbestos only in New York City Board of Education schools.

latter 1970s. Exposures incurred in the course of abatement projects would not be expected to yield radiographically apparent scarring until the latter 1990s at the earliest.

The relationship between the prevalence of radiological abnormality consistent with prior asbestos exposure and time elapsed since the onset of custodial work is evident in FIGURE 2 and TABLE 12. Among those who began custodial work 35 or more years earlier, 53% had abnormal chest X-rays, compared with a 25% rate of radiographic abnormality among those 34 years or less from beginning such work (FIG. 3).

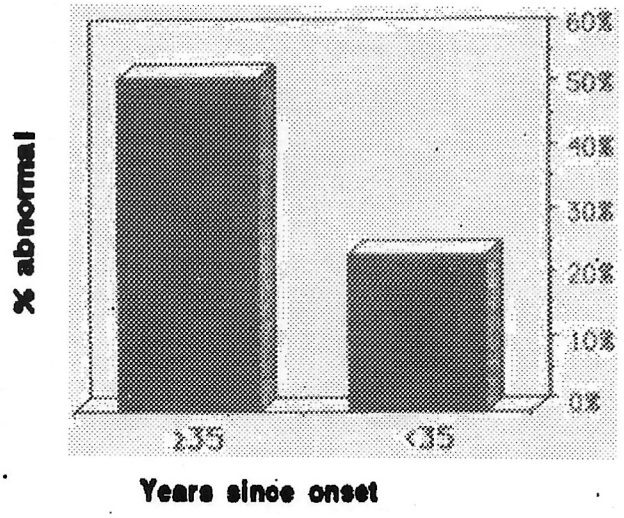



**FIGURE 3.** Radiographic findings and time since Board of Education hire among custodians with exposure to asbestos only in New York City schools.

No relationship was evident between a reported history of frequent past mixing, fixing, or removing asbestos and the prevalence of radiographic abnormality (FIG. 3). No particular work activity was associated with a notably higher prevalence of change on chest X-ray.

## SUMMARY AND CONCLUSIONS

Six hundred sixty custodians employed by the New York City Board of Education underwent examination from 1985 through 1987 for asbestos-related disease and other general medical conditions by the clinical staff of the Division of Environmental and Occupational Medicine of the Mount Sinai School of Medicine of the City University of New York.

Two-thirds of the men (no women were examined) were 20 or more years from onset of any custodial work, with 44% having had at least 20 years of employment as custodial workers in New York City Board of Education schools. Twenty-four percent had begun custodial work in buildings 30 or more years earlier. Findings among them were of particular interest since asbestos-related disease might forecast what might be expected among school custodians with less seniority.

Since the Board of Education, in selecting custodians for examination, had chosen only custodians currently employed, the study group comprised men still working in the school system. These, then, represented a "survivor population" (4% had retired between the time of enrollment in the study and the date of examination, and only one of the seventeen retirees had left work owing to disability).

Although a considerable amount of clinical information was obtained, abnormalities on chest X-ray consistent with asbestos-induced scarring were used as the key index of disease resulting from exposure to asbestos. Since scarring of the lung tissue or lining of the lung or chest wall (pleura) may be present but undetectable on standard chest radiographs (a relatively insensitive diagnostic technique), the prevalence of abnormality on X-ray film represents a conservative estimate of the actual burden of scarring lung disease in the group. Such changes are indicative of previous asbestos exposure, however, and provide evidence of an increased risk of later asbestos-related malignancy.

Overall, abnormalities on chest X-ray consistent with asbestos-related scarring were found in 28% of the men examined. The expected relationship of increasing prevalence of radiographic changes with increasing time since onset of exposure in buildings was demonstrated; among those with 35 or more years since beginning custodial work, 39% had abnormal films. This is evidence that custodial workers as a group have had asbestos exposure in the past, as reflected also in the work histories obtained at the time of examination. Eighty-four percent reported that they themselves removed asbestos-containing materials in the course of their work. Eighty-nine percent had been present in the work area during asbestos abatement projects in the schools in more recent years.

No particular work activity with asbestos-containing materials (mixing, fixing, or removing asbestos) was associated with a remarkably increased prevalence of radiographic abnormality.

A specific analysis of the data was conducted for the 247 school custodians who reported having had no exposure to asbestos apart from their work in the New York City Board of Education schools. The prevalence of radiographic abnormality for this group was 28% overall and 53% for those who had begun employment 35 or more years earlier.

In summary, the data are consistent with the conclusion that custodians employed in New York City Board of Education schools have, in the past, been significantly exposed to asbestos in the course of their work. Approximately half of those with at least 35 years seniority, who reported no asbestos exposure outside the school setting, had abnormal chest X-rays. Those with less seniority are likely to face a similar risk of asbestos-related changes as time goes on, to the extent that comparable exposures continued. Medical surveillance for school custodians should be considered, both for management of complications of asbestotic scarring and to minimize, as much as possible, the toll that may be anticipated from later asbestos-associated neoplasms. Moreover, prevention of additional exposure to asbestos among those currently employed in the schools, or in other buildings containing asbestos materials, is essential to avoid adding to the burden of asbestos-related illness in the future.

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