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The Third Wave of Asbestos Disease: Exposure to Asbestos in Place

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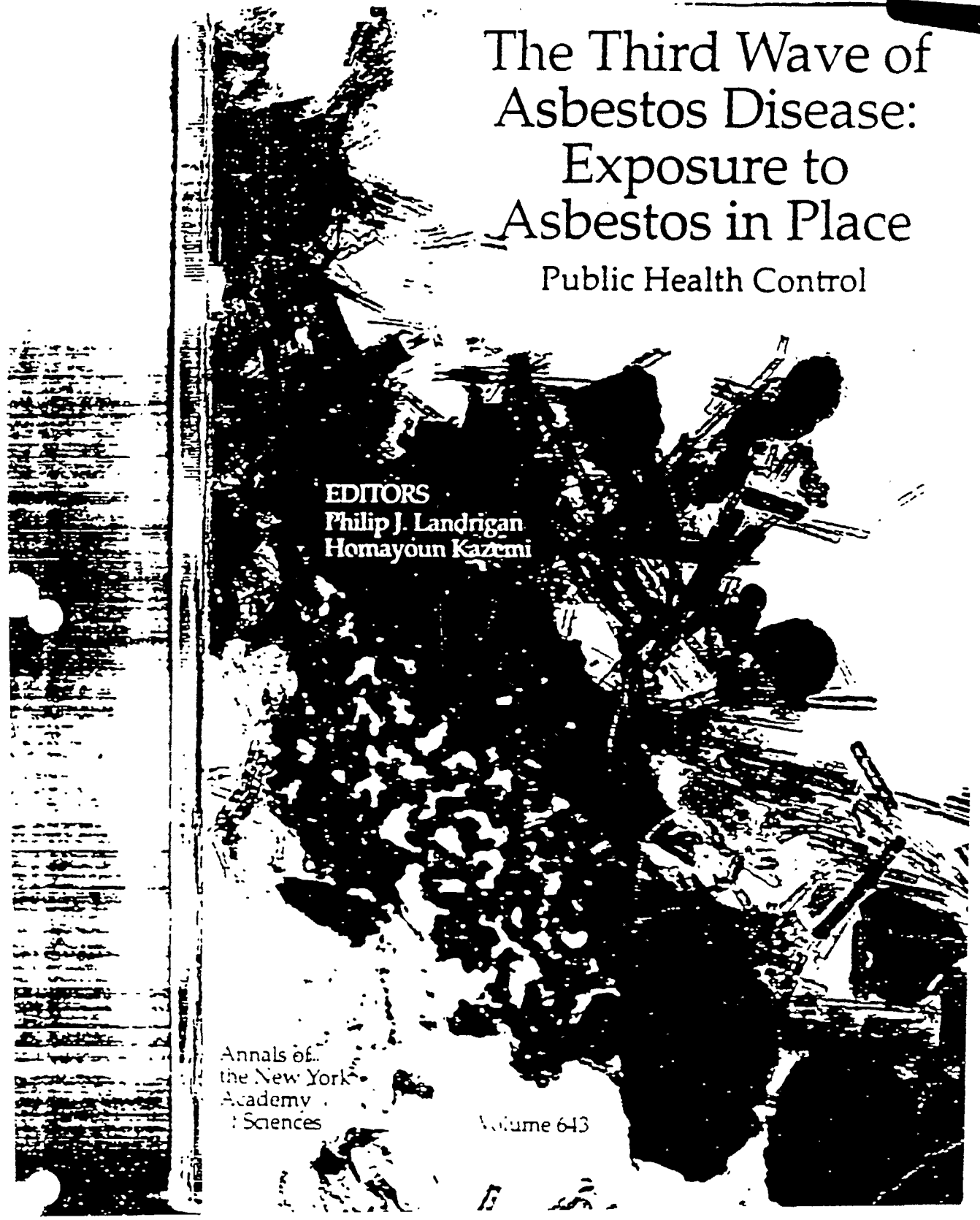

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Asbestos-Related Disease in Employees of a Steel Mill and a Glass Bottle–Manufacturing Plant

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INTRODUCTION

Asbestos is a well-known health hazard. The principal diseases related to asbestos exposure are a variety of nonmalignant pleural disorders including pleural effusion, pleural plaques, and pleural fibrosis, as well as asbestosis, mesothelioma, and cancer of the lung, larynx, and gastrointestinal tract. Initially, most cases of asbestos-related disease were seen in miners, millers, and persons employed in the manufacture of asbestos products.[1] In the late 1950s and early 1960s, asbestos-related disease was reported in end-product users such as insulators, shipyard workers, and railroad workers.[2,3] More recently, workers who did not directly use asbestos have been found to be at risk.[4] In most instances this "third wave" of asbestos disease has involved persons who, while not directly using asbestos themselves, were in situations where their exposure to asbestos was fairly evident. This includes workers in the general construction trades, such as carpenters and sheet-metal workers,[5] and office workers exposed to deteriorating asbestos material.[6] Outside of the petrochemical industry, where there was extensive use of asbestos in pipe insulation, few, if any, reports of asbestos-related disease exist in workers employed in general industry. The purpose of this report is to present preliminary observations on the prevalence of asbestos-related disease in workers at two industrial sites not generally associated with asbestos exposure—a glass bottle-manufacturing plant and a steel mill.

METHODS

The workers reported in this study were referred to the Occupational Medicine Clinic of the University of Texas Health Center at Tyler for assessment of possible asbestos-related disease and other occupational diseases. The patients were identified through direct contact by attorneys, through public meetings, and by contacts made by fellow workers. All workers were encouraged to report for screening; however, this approach necessarily precluded a comprehensive survey of all of the involved workers at these two plants.

Both of the factories involved in the study were located in northeast Texas in a relatively rural area that is not heavily industrialized. The glass bottle plant operated from 1948 to 1964, when it closed primarily for economic reasons. During the

36 years of its operation this plant employed a total of approximately 1,500 workers. The steel mill also opened in 1948 and is still operating, although at a reduced capacity. A total of approximately 8,000 workers were employed at this plant during its years of operation. The extent of asbestos in place in these two factories is not known with certainty, nor is it known precisely what types of asbestos were used. In both instances asbestos was used extensively during processes that involved heating, primarily as an insulation material. The workers were all blue collar and did not include managers or office personnel. The majority of the workers had lived most of their lives in the surrounding area of East Texas. They were employed in many different areas of the plant. None of the workers reported in this study was assigned to work directly with asbestos as part of his or her usual duties and none gave a history of having worked directly with asbestos during any previous employment. In addition to being exposed to asbestos, the workers in these two factories had significant exposure to other occupational hazards including silica, mixed dusts, and a variety of organic and inorganic toxins. While it is difficult to quantitate the extent of these exposures, we estimate from the histories provided by the workers that those at the glass bottle plant had more direct silica exposure than did those at the steel mill, while the reverse was true for toxin exposure. Mixed dust exposure occurred in both.

The evaluation performed differed in the two groups of workers in that the glass bottle plant workers were more extensively evaluated. The difference in the two evaluations related primarily to the size of the two groups of workers, with the large number of steel mill workers precluding the extensive initial evaluation performed in the glass bottle plant workers. Each of the glass bottle plant workers had a complete medical and occupational history and physical examination, posteroanterior, lateral, and right and left anterior oblique chest X-ray films with ILO reading [illegible] and complete pulmonary function testing. All of the chest X-rays on the steel workers and 85% of the chest X-rays on the glass workers were read by the [illegible] reader. The majority of the glass workers also had fiberoptic bronchoscopy with bronchoalveolar lavage (BAL). Specific pulmonary function tests in[illegible] and determination of lung volume [illegible] plethysmography, and [illegible] carbon monoxide diffusing capacity. Lung volumes were calculated [illegible] residual capacity measured in [illegible] pressure constant[illegible] CPI 2000 Sensor Medic[illegible] breath carbon monox[illegible] was performed using the technique [illegible] and was [illegible] normal values calculated from the equation of Miller et al.[illegible] and volumes were those of Boren [illegible] for men and Gold[illegible] women. Normal values for [illegible] indices were those [illegible]

[illegible] lavage was performed as previously described. After ad[illegible] anesthesia, a fiberoptic bronchoscope was inserted into the [illegible] A total of 100 ml of normal saline solution was injected in [illegible] both the lingula and right middle lobe. The fluid was aspirated [illegible] each aliquot and filtered through gauze. Typically, 80 to 100 ml [illegible] of saline solution in the BAL was recovered. A small aliquot [illegible] used for white blood cell and differential counts. Differential [illegible] from cytocentrifuge preparations (Cytospin II, Shandon[illegible] Sewickley, PA) which were then stained with a modified [illegible] Harleco Diff-Quik, Dade Diagnostics, Aquada, PR. At [illegible] were counted using morphologic criteria to detect the percentage of [illegible] lymphocytes, neutrophils, and eosinophils present. Total BAL [illegible] were measured with a hemocytometer. Ferruginous bodies (FB) and

uncoated asbestos fibers were enumerated by means of light and transmission electron microscopy (TEM). Asbestos and other dust particles and fibers were identified by X-ray diffraction spectroscopy.[11] All of the glass workers underwent lavage unless they had significant cardiorespiratory disease or refused the procedure.

The steel mill workers were evaluated with a screening medical and occupational history and physical examination performed by an occupational medicine nurse. They also had posteroanterior and lateral chest X-ray films, as well as spirometry, but not complete pulmonary function testing. Bronchoalveolar lavage was not performed on the steel plant workers.

Asbestos-related disease in these two groups of workers was classified into one of four categories—pleural disease, asbestosis, restrictive pulmonary function, and cancer (mesothelioma or cancer of the lung, larynx, or gastrointestinal tract). A number of workers had disease in more than one category. Pleural disease was defined by the presence of pleural plaques occurring primarily over the lower lobes or diaphragm with or without calcification or by diffuse pleural fibrosis. Asbestosis was defined by a profusion score of 1/0 or greater on the ILO reading of the posteroanterior chest X-ray. In the glass bottle plant workers, restrictive pulmonary function was defined by a reduced vital capacity, a reduced total lung capacity, and a reduced diffusion along with a normal FEV_1/FVC ratio. Since only spirometry was available in the steel workers, restrictive pulmonary function was defined as a reduced FVC with a normal FEV_1/FVC ratio in that group. Whenever possible, the diagnosis of cancer was confirmed by examination of tissue. When this was not possible, the diagnosis of cancer was accepted on the basis of outside medical records or the patient's own history. The one case of pleural mesothelioma that occurred in a steel worker was diagnosed at autopsy. Since the workers at these two plants were referred for evaluation of all possible occupational diseases and not just asbestos-related disease, a number of younger workers with short exposures and latency were studied. All of the workers studied are included in the data, but only asbestos-related disease is addressed in this report.

RESULTS

The demographics of the two groups of workers are described in TABLE I. Both groups were similar to each other and similar to other groups of workers exposed to asbestos. The majority were men and more than two-thirds were current or former cigarette smokers. The steel workers were somewhat older as a group, but both groups had a wide range of ages. Both groups were exposed for an average of around 20 years, with a latency of around 30 years.

Of the 334 glass plant workers seen, 91 or 27% had one or more categories of asbestos-related disease (TABLE 2). The most common category was pleural disease which occurred in 38 workers or 42% of the 91 workers with asbestos-related disease. There were 22 cases of asbestosis and 12 of cancer of the lung, larynx, or gastrointestinal tract among the glass plant workers. Of these 12 cases of cancer, that of the lung was by far the most common (10 cases). The other two occurrences of cancer involved the gastrointestinal tract. Restrictive pulmonary function was seen in 19 workers.

Bronchoalveolar lavage was performed in 30% of the 334 glass workers referred for assessment (TABLE 3). The majority of the 29 workers who did not have BAL were excluded because they suffered from significant cardiorespiratory dis-

TABLE 1. Demographic Features of Participants in Occupational Health Survey Texas, 1989–1990

	Glass Workers	Steel Workers
Total number of workers examined	334	898
Percentage of men	80	98
Age ($\bar{X}$ and range)	49 (25–83)	58 (28–91)
Percentage of Smokers	67	70
Years exposed ($\bar{X}$ and range)	17 (6 months–36 yr)	23 (6 months–41 yr)
Years from first exposure ($\bar{X}$ and range)	32 (7–53)	29 (1–49)

TABLE 2. Asbestos-Related Disease in Survey of 334 Glass Plant Workers, 1989–1990

	Number	Percentage of Abnormal
Pleural disease	38	42
Fibrosis (≥ ILO grade 1/0)	22	24
Cancer (lung, larynx, gastrointestinal tract)	12	13
Restrictive pulmonary function	19	21
Total number of workers seen	334	
Total number with abnormalities	[illegible]	

TABLE 3. Results of Bronchoalveolar Lavage Performed in 305 Glass Plant Workers, 1989–1990

	Number	Percent
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] morphonuclear leukocytes	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TABLE 4. Asbestos Related Disease in 898 Steel Plant Workers, 1989–1990

	Number	Percentage of Abnormal
[illegible] function	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] gastrointestinal tract	[illegible]	[illegible]
[illegible] grade 1/0	[illegible]	13
[illegible]	[illegible]	
[illegible] number of workers seen	[illegible]	
[illegible] number with abnormalities	[illegible]	[illegible]

ease. Five workers either refused the procedure or did not have it for technical reasons. The majority of the lavages failed to yield findings suggestive of asbestos exposure or disease. Positive findings on BAL included the presence of asbestos fibers, ferruginous bodies, or alveolitis denned by more than 10% polymorphonuclear leukocytes (PMNs) in the BAL fluid. All of the asbestos fibers seen were either chrysotile or amosite asbestos, with the great majority being chrysotile.

The study of asbestos-related disease in the steel plant workers constitutes work in progress in that this report summarizes the assessment of that portion of the workers screened as of April 1990 (TABLE 4). Of these 898 workers, 157 or 17.5% had one of the four categories of asbestos-related disease. The majority of these 157 workers had restrictive pulmonary function seen on spirometry followed by pleural disease, cancer of the lung, larynx, or gastrointestinal tract, and asbestosis. The majority of the cases of cancer seen in this group occurred in the

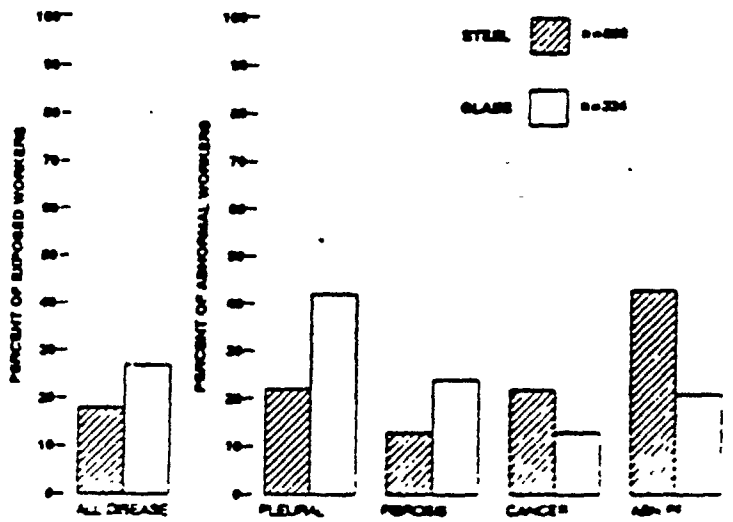

FIGURE 1. A comparison of asbestos-related disease in steel mill and glass bottling plant workers

gastrointestinal tract (17 cases) followed by the lung (10 cases) and larynx (7 cases). There was one case of pleural mesothelioma in the steel workers.

The types of asbestos-related disease in the two groups of workers are compared in FIGURE 1. The overall prevalence of disease was similar in the two groups, being just under 20% in the steel workers and just under 18% in the glass workers. Pleural disease was the most common manifestation of asbestos-related disease in the glass workers, whereas restrictive pulmonary function was the most common entity in the steel workers.

DISCUSSION

The principal finding of this study is the presence of significant numbers of workers with asbestos-related disease in two industrial sites, a steel mill and a glass bottle-manufacturing plant, not generally associated with a high risk of

asbestos-induced disease. Although the prevalence of disease in these two plants is somewhat lower than that reported in workers in the general construction trades, it is still significant, with an overall prevalence of greater than 20%. The industrial processes occurring at these two plants were diverse, but were not specifically reported to include asbestos or asbestos-containing materials. The workers tended to move around the plant and were exposed to several areas where thermal insulation was present. They were not, however, in trades known to work with asbestos (i.e., they were not insulators, plumbers, or pipe fitters). Although the exact source of asbestos exposure in these workers is not known, the one industrial process common to both plants is the use of intense heat necessary to produce molten glass and steel. In both plants, asbestos was used extensively as an insulator and fire retardant around the furnaces and on the assembly line carrying the molten material. Workers reported they would occasionally repair, cut, and shape this material, which was in various states of deterioration. The repair and maintenance of this asbestos material did not, however, constitute their primary job task or even a significant portion of their job at the plant or mill. It is also likely, given the age of these two plants, that they contained considerable amounts of asbestos insulation and fireproofing as part of their general construction.[4] It seems probable that workers at industrial sites of comparable age which use intense heat in their manufacturing process should be considered at risk for asbestos-related disease. This might include automobile manufacturing plants, aluminum smelters, forges and foundries.

This is not a true cross-sectional study in that no attempt was made to conduct a comprehensive survey of all the workers at these two sites. Therefore the true prevalence of asbestos-associated disease at these two plants cannot be determined by this study. It is possible that the data presented underestimate the incidence of disease at these two plants. Since fewer than half of the total number of workers employed presented themselves for study, selection bias suggests that the [illegible] workers would not have come forward for screening and the remaining [illegible] workers may have a higher incidence of disease. Another uncertainty in the [illegible] the true prevalence of asbestos-related disease at these two plants [illegible] results of basing most of the diagnoses on chest evidence rather [illegible] tissue. The BAL data in the 2 asbestos workers do however [illegible] tissue burden of asbestos fibers and ferruginous bodies [illegible] have demonstrated a good correlation between the presence [illegible] in the BAL fluid and tissue burden of asbestos.[5]

[illegible] presented in this report represent preliminary observations and raise [illegible] for further study. It will be necessary to conduct true cross-sectional as well as prospective studies at similar industrial sites in order to [illegible] risk of asbestos-associated disease in these workers. The role [illegible] this tool deserves further evaluation, particularly in terms of [illegible] other markers of asbestos-induced disease and consequent [illegible] detection and intervention. Which workers should be [illegible] is another important question to be answered. This [illegible] however that asbestos in place in [illegible] sites constitutes a [illegible] asbestos-induced disease.

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