

Asbestos Disease in Family Contacts of Shipyard Workers

KAYE H. KILBURN, MD, RUTH LILIS, MD, HENRY A. ANDERSON, MD, C. THOMAS BOYLEN, MD,
HANS E. FUNSTEIN, MD, SUE-J. S. JOHNSON, MD, AND RAPHAEL WARSHAW, BA

Abstract: Radiologic signs of pulmonary asbestos disease were found in 11.3 per cent of 274 wives of shipyard workers who were 20 or more years from initial hiring on in shipyards in Los Angeles County. Asbestosis was also found in 7.6 per cent of 79 sons and 2.1 per cent of 140 daughters of these workers. The wives, sons, and

daughters were without occupational exposure. Comparable radiographic signs were not found in comparison groups. It is probable that asbestos exposure in the household places these family members at risk for mesothelioma and lung cancer. (*Am J Public Health* 1985; 75:615-617.)

Introduction

Health risks^{1,2} are associated with even brief proximity to airborne asbestos fibers³ in many different work places. The risk associated with less direct exposure, although originally described by Wagner in 1960⁴ and later by Newhouse and Thompson in 1965,⁵ has received little attention. In one study, family contacts of asbestos insulation production workers showed a 35 per cent overall prevalence of radiographic abnormalities characteristic of asbestosis and resulting from secondary exposures in their homes.⁶

Shipyards have been the site of widespread exposure to asbestos for at least 3.5 million workers in various trades, and radiographically detectable asbestosis has been reported in several groups of such workers.⁷⁻⁹ In a recent study of 286 current and retired ship repair workers, most of whom were in "bystander" trades not working directly with asbestos, 86 per cent had asbestosis, and lung cancer was detected in five.¹⁰ The risks for asbestos disease have not been assessed previously in family contacts of bystander workers.

This report concerns 852 subjects who were studied in 1981, and includes male and female shipyard workers and their wives, daughters, and sons. The objective was to determine the prevalence of asbestosis, i.e., diffuse pulmonary fibrosis and/or pleural fibrosis including calcification as seen by chest radiographs, in household exposed wives and children of shipyard workers, and to compare such prevalences to those in populations not so exposed.

Methods

The population studied consisted of 1,017 workers and their wives, sons, and daughters recruited from the Long Beach, Wilmington, and San Pedro areas of Los Angeles County by a public media campaign. Each respondent was screened briefly by a telephone interviewer to determine if the worker was 20 years or more from initial shipyard employment, i.e., first exposure to asbestos. Appointments were made for examinations during May 1981.

Address reprint requests to Kaye H. Kilburn, MD, Professor of Medicine, and Chief, Pulmonary Disease Section, Department of Medicine, University of Southern California School of Medicine, Harbor USC Occupational Health Center, 2025 Zonal Avenue, Los Angeles, CA 90033. Authors Boylen, Funstein, Johnson, and Warshaw are also with the Harbor USC Occupational Health Center. Dr. Lilis is with the Environmental Sciences Laboratory, Mt. Sinai School of Medicine, CUNY, New York; Dr. Anderson is with the Wisconsin State Board of Health, Environmental Epidemiology, Madison. This paper, submitted to the *Journal* April 26, 1984, was revised and accepted for publication January 3, 1985.

© 1985 American Journal of Public Health 0090-0001/85 \$1.50

After informed consent was obtained, trained interviewers obtained information about occupational exposure and working conditions, pulmonary and cardiac diseases, respiratory symptoms, particularly shortness of breath, cough, sputum, and wheezing, and knowledge and attitudes about asbestos disease. The occupational questionnaire was based on that used in a prior study of family contacts of asbestos workers⁶ and in the studies for the effects of polybrominated biphenyls in the State of Michigan.¹¹ The respiratory disease questionnaire included the Medical Research Council chronic bronchitis questions with additions concerning asthma and the degree of breathlessness as recommended in the epidemiology standardization project.¹²

From 1,017 subjects studied, 13 were excluded as distant relatives who were outside the study categories and 13 subjects had incomplete data, usually having refused chest x-rays. There were 76 subjects whose asbestos exposure was at work sites other than shipyards. Thirty-nine sons and daughters were excluded because their fathers were less than 20 years from initial occupational exposure to asbestos. An additional 24 shipyard workers, both men and women, also were less than 20 years from initial exposure to asbestos.

The 485 women analyzed were either female shipyard workers, or wives or daughters of workers; 24 per cent were employed but none of the wives or daughters had worked with asbestos (Table 1). Comparisons were made with two other groups of adult women^{13,14} (Table 1) who had been studied using chest radiographs and questionnaires similar to those used in this study. The 79 sons of shipyard workers were compared to 673 men (mean age 50 ± 17) from the Long Beach census tract¹⁵ and 594 men (mean age 43 ± 14) from the Michigan sample.¹⁶

Posteroanterior and lateral chest radiographs (14 × 17 inch) were obtained in all subjects at standard six foot distance using conventional techniques. Chest radiographs were screened by a physician and repeated if they appeared technically unsatisfactory for evaluation of pneumoconiosis by ILO (International Labour Organization) criteria. Thereafter, three experienced readers with at least "B" reader qualifications for reading pneumoconiosis (as established by the American College of Radiology) independently read the posteroanterior radiographs of all three groups for presence and profusion of irregular opacities and presence and extent of pleural abnormalities (diffuse thickening, plaques, and calcification). They used the criteria of the 1980 revision of the ILO classification for pneumoconiosis¹⁴ which grades the profusion of opacities from absent (grade 0) to few (grade 1), to moderate (grade 2), and numerous (grade 3). All study and control x-rays had identification covered and were intermixed. The x-rays were graded from 0/0 to 3/3 by

TABLE 1—Comparisons of Three Groups of Volunteer Women

Demographics	Women in This Study	Reference Group 1*	Reference Group 2**
Per Cent by Age	(N:485)	(N:674)	(N:583)
18-34	22	25	43
35-54	32	22	35
55+	45	42	21
ages missing	1	11	1
Per Cent by Race			
White	86	99	93
Black	13	0	6
Other	1	1	1
% Employed	24	unknown	54
% Exposed to asbestos at work	0	3	5
% Possibly exposed to asbestos at home	100	6	16

*Census tract house to house survey recruitment, Long Beach, CA, 1975-1976; 76% of those invited were examined (13).

**Stratified random sample, recruited by phone, Michigan, 1978; 43% of those invited were examined (11).

arithmetic consensus of the three gradings. To be considered positive, two readings had to indicate the presence of asbestosis grade 1/0, or definite pleural abnormalities. Readings which differed by two or more grades of profusion, for example 1/0 to 1/2 or 2/1, were reviewed by the three readers as a panel until they reached a consensus. For the following analysis irregular opacities with a profusion of 1/0 or greater were considered as positive for asbestosis as recommended by ILO criteria. Similarly, pleural findings were counted as positive if any combination of pleural thickening, plaques, and calcification were consistent with asbestos disease. The term asbestosis, when used in this report, is synonymous with radiologic signs of this condition.

TABLE 2—Prevalence of Asbestosis of Lungs and/or Pleura for Shipyard Workers and Family Contacts and in Long Beach and Michigan Comparison Populations

Groups	n	Per Cent with Asbestosis
Male Shipyard Workers	288	64.2
Female Shipyard Workers	71	21.1
Wives of Shipyard Workers	274	11.3
Sons of Shipyard Workers	79	7.6
Daughters of Shipyard Workers	140	2.1
Comparison Population		
Long Beach Census Tract Men	673	3.7
Long Beach Census Tract Women	674	0.6
Michigan Sample Men	564	0.5
Michigan Sample Women	583	0.0

Decade of birth was used as an approximation of years from initial exposure to asbestos for creating four groups so that asbestosis prevalence could be compared in shipyard workers and their wives. This was done because exact dates of first asbestos contact were unknown or first contact was outside of shipyards.

Results

The prevalence of asbestosis in the shipyard workers and their wives and children is shown in Table 2; a detailed breakdown of diagnostic criteria appears in Table 3. The male workers had engaged in all skilled shipyard trades. Many had begun as laborers and no trade predominated. Their mean age was 61 (± 10.8); 81 per cent had a history of cigarette smoking, although at the time of the study, only 25 per cent continued to smoke. Asbestosis was present in 185 (64.2 per cent) of the male shipyard workers.

TABLE 3—Radiologic Signs of Asbestosis in Different Groups of Individuals

Group/Disease	Profusion of Irregular Opacities					Total (%)
	0/0	0/1	1/0	1/1	>1/1	
Male Shipyard Workers (N = 288)						
IO only	99	72	53	50	14	51 (17.7)
PT + PC	26	42				68 (23.6)
PT + PC + IO			27	29	10	66 (22.9)
Negative	73	30				103 (35.8)
Female Shipyard Workers (N = 71)						
IO only	50	14	4	1	2	5 (7.0)
PT + PC	5	3				8 (11.3)
PT + PC + IO			1	0	1	2 (2.8)
Negative	45	11				56 (78.9)
Wives (N = 274)						
IO only	221	34	16	3	0	18 (5.8)
PT + PC	5	7				12 (4.4)
PT + PC + IO	0		2	1	0	3 (1.1)
Negative	216	27				243 (88.7)
Sons (N = 79)						
IO only	69	7	2	1	0	3 (3.8)
PT + PC	2	1				3 (3.8)
PT + PC + IO			2	0	0	3 (2.5)
Negative	27	6				73 (92.4)
Daughters (N = 140)						
IO only	132	7	1	0	0	1 (0.7)
PT + PC	2	0				2 (1.4)
PT + PC + IO			0	0	0	
Negative	130	7				137 (97.9)

NOTES: IO = irregular opacities in lung.
PT + PC = pleural thickening and/or calcification.
Underlined numbers were counted in calculating prevalence.

All of the women shipyard workers were wives of male shipyard workers; two had been insulators and one had been a welder; 32 were present or former cigarette smokers; 21.1 per cent had asbestosis.

Mean age of 274 wives was 58 (± 9.5); asbestosis was found in 11.3 per cent and was equally frequent in nonsmokers, ex-smokers, and current smokers. Three wives who were cigarette smokers had lung masses detected by chest radiograph. Two of these were cancers and one was sarcoidosis.

Six of 79 sons (mean age 29.5 ± 8.3) had asbestosis, as compared to three of the 140 daughters (mean age 32.3 ± 10.3).

Analysis of workers by decade of birth showed a strong relationship between decade of birth and asbestosis prevalence in shipyard workers; in the wives of workers, the relationship is less striking but remains suggestive (Table 4).

As shown in Table 2, the prevalence of radiologic signs of asbestosis were far higher in the wives, sons, and daughters of shipyard workers than in the two comparison groups studied.

Discussion

Most of the shipyard workers studied did not work directly with asbestos, but were exposed to airborne asbestos during application and ripout of insulation by pipe coverers and insulators. Finding asbestosis signs in 11.3 per cent of their wives is fresh evidence of the pervasiveness of asbestos as an occupational hazard carried home by workers. Those wives born in the decade 1900-10 had the highest proportion of asbestos signs, two-thirds as high as the 48 per cent in wives of Paterson, New Jersey insulation factory workers studied by Anderson, *et al.*^{6,15}

Sons without occupational exposure to asbestos had a 7.6 per cent prevalence which is in keeping with their youth. If exposure of the sons began in infancy, they may continue to develop asbestos signs throughout their lifetimes, and the prevalence will rise as they grow older. Only 2.1 per cent of daughters had asbestos signs. A similar sex difference was found at Paterson.¹⁴ Reasons for the difference are unknown, but may reflect greater difficulty in recognizing irregular opacities through the breast shadows on chest radiographs.

Although shipyard workers appear to have lower exposures to asbestos compared to those making asbestos insulation products,⁷⁻⁹ the gradient of asbestos signs with earlier decades of birth suggests that the time lapsed from first exposure may be a more important determinant than is the average dose.

TABLE 4—Comparison of the Prevalence of Asbestosis in Workers and Wives, by Decade of Birth

Decade of Birth	Male Shipyard Workers		Wives*	
	N	% Positive	N	% Positive
1900-10	37	86.5	22	31.8
1911-20	117	70.1	90	12.2
1921-30	83	81.7	102	7.8
1931-40	39	30.8	49	10.2

*Includes only wives who were not shipyard workers or were not otherwise exposed to asbestos.

All studies, particularly those involving human volunteers, may be biased. It is possible that the shipyard workers and family members who volunteered for this study were more aware of the dangers of asbestos exposure and that a higher proportion had been previously diagnosed with asbestosis than a random sample of families of present and former shipyard workers. However, we collected data during this study about health awareness and previously recognized respiratory diseases and symptoms. Analysis of these data (to be reported later) did not bear out this possibility.

Although data on risks to family contacts of shipyard workers are still incomplete, five mesotheliomas have been recognized in family members of asbestos insulation manufacturing workers in Paterson.⁶ We believe that, the feasibility and benefits of undertaking surveillance for cancer in the families of workers exposed to asbestos should be considered, particularly for individuals who continue to smoke cigarettes or who have smoked for many years in the past.

*Anderson HA. Unpublished data.

REFERENCES

1. Selikoff IJ, Chura J (eds): Biological effects of asbestos. *Ann NY Acad Sci* 1965; 112:1-766.
2. Selikoff IJ, Hammond EC (eds): Multiple risk factors in environmental cancer. In: Fraumeni JF Jr (ed): *Persons at High Risk for Cancer*, New York: Academic Press, 1978.
3. Seidman H, Selikoff IJ, Hammond EC: Short-term asbestos work exposure and long-term observation. *Ann NY Acad Sci* 1979; 330:61-89.
4. Wagner JC, Siegel CA, Marchand P: Diffuse pleural mesothelioma and asbestos exposure in the North Western Cape province. *Br J Ind Med* 1980; 17:260-271.
5. Newhouse ML, Thompson H: Mesothelioma of pleura and peritoneum following exposure to asbestos in the London area. *Br J Ind Med* 1965; 22:261-269.
6. Anderson HA, Litis R, Daum SM, Fischbein AS, Selikoff IJ: Household contact asbestos neoplastic risk. *Ann NY Acad Sci* 1976; 271:311-323.
7. Selikoff IJ, Litis R, Nicholson WJ: Asbestos disease in United States shipyards. *Ann NY Acad Sci* 1979; 330:295-311.
8. Polakoff PL, Horn BR, Scherer OR: Prevalence of radiographic abnormalities among northern California shipyard workers. *Ann NY Acad Sci* 1979; 330:333-339.
9. Felton JS: Radiographic search for asbestos-related disease in a naval shipyard. *Ann NY Acad Sci* 1979; 330:341-352.
10. Selikoff IJ, Nicholson WJ, Litis R: Radiological evidence of asbestos disease among ship repair workers. *Am J Ind Med* 1980; 1:9-22.
11. Selikoff IJ, Anderson HA: A survey of the general population of Michigan for health effects of polybrominated biphenyl exposure. In: Report to the Michigan Department of Public Health, September 30, 1979. Environmental Science Laboratory, Mt. Sinai School of Medicine.
12. Ferns BG Jr: Epidemiology standardization project. II. recommended respiratory disease questionnaires for use with adults and children in epidemiological research. *Am Rev Respir Dis* 1978; 118 (No 6 Part 2) 7-35.
13. Detels R, Savre JW, Coulson AH, Rokaw SN, Massey FJ Jr, Tashkin DP, Wu Mei-Mian: The UCLA population studies of chronic obstructive respiratory disease: IV. respiratory effect of long-term exposure to photochemical oxidants, nitrogen, and sulfates on current and never smokers. *Am Rev Respir Dis* 1981; 124:673-680.
14. International Labour Office: International classification of radiographs of pneumoconiosis 1980. Occupational Safety and Health Series 22. Geneva, ILO, 1980.
15. Anderson HA, Litis R, Daum SM, Selikoff IJ: Asbestosis among household contacts of asbestos factory workers. *Ann NY Acad Sci* 1979; 330:387-399.

ACKNOWLEDGMENTS

This research supported by a grant from the American Lung Association of Los Angeles County. This study was presented in part to the American Thoracic Society meeting, May 9, 1981.