

is impossible to predict accurately the health effects of occupational exposure to carcinogens such as asbestos, radon gas, and arsenic. Unfortunately, in only a few of the studies listed in Table 4 have adequate assessments been made of the proportion of workers who smoke cigarettes.

The contribution of cigarette smoking to the increased incidence of disease has been evaluated in several studies and has led to a consensus that this habit produces a very significant increase in risk of dying of lung cancer, as well as of the various cardiovascular diseases. The largest study of cigarette smokers is that of E. Cuyler Hammond and colleagues under the auspices of the American Cancer Society. This study is based on questionnaires and mortality follow-up accomplished between July 1960 and June 1971 for approximately 51,000 men (Hammond *et al.*, 1978). The proportional mortality of lung cancer (percent lung cancer deaths relative to deaths by all causes), based on the Hammond study, is shown graphically in Figure 7. For a group of men who all smoke cigarettes (cohort of 100 percent smokers) lung cancer mortality is approximately 7 percent at age 45, reaches a maximum of approximately 10 percent at age 70, then decreases slightly at older ages. For a cohort of male non-smokers, lung cancer mortality is 2 percent at age 45 and then decreases continuously to approximately 1 percent at age 95.

Smoking is most prevalent in blue-collar occupations relative to professional and managerial occupations (Sterling and Weinkam, 1978). This prevalence also holds true for the asbestos trades, mining, and milling occupations. In a group of 13,722 asbestos insulation workers whose smoking habits were recorded, 70 percent had a history of cigarette smoking (Selikoff and Hammond, 1975; Saracci, 1977). In a group of 1,015 chrysotile asbestos miners and millers, 85 percent were smokers (McDonald *et al.*, 1974). Data given in Figure 7 predicts that the lung cancer mortality for a cohort composed of 75 percent smokers would be at least 6 to 7.5 percent, regardless of occupation. In Table 4 we see that the lung cancer mortality for the total of 13 cohorts of asbestos "trades" workers was 18.3 percent — approximately three times that expected if mortality predictions were based only on the apparent smoking habits.

The increased risk of lung cancer due to asbestos exposure in non-smokers is very low (Saracci, 1977). There appears to be no relationship

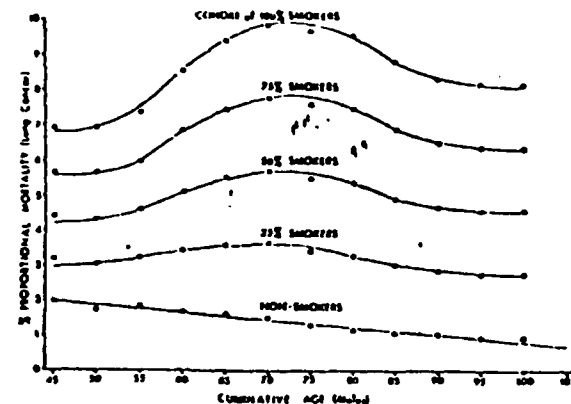


Figure 7. Percent of lung cancer deaths in males relative to deaths by all causes (proportional mortality - lung cancer) plotted with respect to age for four groups (cohorts) with different cigarette smoking characteristics and for a cohort of non-smokers. For example, for a cohort of 70-year old males which is composed of 75 percent cigarette smokers, 7.8 percent of all deaths at age 70 are predicted to be from lung cancer. Graphical presentation based on data from Hammond *et al.* (1978).

Table 6. Cancer mortality for men working in the asbestos "trades"

Study No.	Ref. 1/	Occupation	No. in cohort	No. deaths	Lung cancer No.	Lung cancer (%) 2/	Asbestosis No.	Asbestosis (%) 2/
1	(A)	Insulators, W.-M. (1941-74)	632	451	89	(19.7)	35	(7.8)
2	(B)	Insulators, U.S. Canada (1947-76)	17000	2770	685	(21.4)	175	(7.7)
3	(A)	Factory, W.J. (1941-74)	933	643	83	(17.7)	10	(2.1)
4	(C)	Insulators, U.S. (1947-71)	7200	640	79	(17.7)	23	(5.2)
5	(B)	Factory, U.S. (1949-74)	689	774	35	(17.4)	26	(9.5)
6	(B)	Factory, England (1931-74)	11042/	217	91	(18.1)	10	(7.2)
7	(E)	Insulators, N.Y. (1945-65)	152	46	18	(21.7)	3	(6.3)
8	(F)	Insulators, Belfast (1948-68)	130	94	24	(24.3)	7	(7.3)
9	(D)	Toxiles, London (1931-70)	6760	350	83	(18.0)	24	(4.4)
10	(A)	Factory, Cardiff (1934-62)	1165	113	11	(8.3)	1	(0.4)
11	(E)	Factory, Penn. (1938-74)	1264	330	26	(10.4)	4	(2.4)
12	(A)	Toxiles (1933-74)	674	104	24	(19.6)	5	(7.1)
13	(A)	Factory, U.S.A. 3/ (1945-74)	764	64	0	(0.1)	0	0
Total of cohorts			3904	5474	408	(18.3)	127	(5.0)

1/ References: (A) Selikoff, 1977; (B) Richardson *et al.*, 1978; (C) Selikoff *et al.*, 1973; (D) Peio *et al.*, 1977; (E) Skolnick *et al.*, 1967; (F) Elms and Simpson, 1971; (G) Marmorek, 1973; (H) Elms and Cochran, 1964; (I) Mancuso and (J) Altar, 1967; (K) Peio, 1978; (L) Weiss, 1977.

2/ Includes 294 women

3/ percent of all deaths (i.e., proportional mortality)

4/ workers were exposed only to chrysotile asbestos