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A FOLLOW-UP STUDY OF WORKERS FROM AN ASBESTOS FACTORY

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Associations between exposure to asbestos and carcinoma of the lung, diffuse mesothelioma of the pleura, and diffuse abdominal tumours have been demonstrated. Only by an epidemiological approach can the total risks of exposure to asbestos be estimated, and such a study is reported here. This suggests that white asbestos (chrysotile) may not be a serious hazard as far as mesothelioma or abdominal tumours are concerned, though there is some evidence of an excess in the number of deaths from carcinoma of the lung and bronchus.

A causative association between asbestosis and carcinoma of the lung has been known to exist for many years (Lynch and Smith, 1935), and it has more recently been shown that lung cancer is a specific industrial hazard of certain workers who have been heavily exposed to asbestos (Doll, 1955). More recently an association between exposure to asbestos and diffuse mesothelioma of the pleura (Wagner, Sleggs, and Marchand, 1960) and diffuse abdominal tumours (Enticknap and Smither, 1964) has been postulated. However, few data relating to the prevalence of mesothelioma, or indeed of carcinoma of the lung, in defined groups of workers who had been exposed to asbestos have been published, and data based on necropsies may, because of the selection of workers so examined and a lack of knowledge of the total population from which they are drawn, give a false impression of their prevalence.

Selikoff, Churge, and Hammond (1963) followed up 632 asbestos insulation workers with a history of 20 years or more since their first exposure to asbestos dust. During the 20 years immediately before the study, 255 had died, 45 (17·6%) due to malignant tumours of the lung or pleura. Three mesotheliomata of the pleura (1·2% of all deaths) and one of the peritoneum were found, and they also noted carcinoma of the gastro-intestinal tract in 29 (11·4%) of all deaths. The numbers of deaths from all these causes were considerably in excess of those expected on the basis of the mortality experience of all white males in the United States during the same period.

A similar study was reported by Mancuso and Coulter (1963), who in 1960 followed up 1,266 men and 229 women who had worked in an asbestos works in Ohio in 1938 or 1939. They found a small excess in the number of deaths in each sex from all causes, which was more marked in deaths due to neoplasms and asbestosis compared with the numbers expected on the basis of death rates during the same period for the area in which the asbestos works was situated.

The following is a report of a follow-up study of all persons who, since 1936, had worked in an asbestos works near Cardiff for a period of six months or longer. The management and type of work done in this factory had changed in 1935, and complete records were available only for the subsequent period, but before this change some asbestos had been used. Asbestos sheeting for the building industry and pipe lagging are the main products of the factory, and since 1935 only chrysotile from southern Africa and from Canada have been used, though it is possible that some crocidolite may have been used during the period 1932-35 in the manufacture of high-pressure pipes.

No mention of the reasons for this study was made to any of the persons or agencies contacted, other than the management of the factory concerned.

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Although this made the field work of the study much more difficult, it was thought essential to do it in this way.

Results

In all, 1,165 men and 268 women had worked in the factory for six months or more during the period 1936 to 1962 inclusive. Of these, 1,024 men (88%) and 237 women (88%) were traced, and, of these, 133 men and 11 women were found to have died, 13% and 5% of the numbers of men and women traced respectively (Table 1). The cause of death was ascertained for 127 of these (Table 2).

No death due to a diffuse abdominal neoplasm was identified, but one man was found to have died from mesothelioma of the pleura. He was born in 1906 and had worked first in a cement works. He had entered the asbestos industry in 1932 and had worked as a beater attendant for four years. He had then been transferred to the drawing office of the asbestos works where he remained until 1953 when he left the industry. Apart from this man, 11 had died from carcinoma of the lung or bronchus (I.S.C.* 162 and 163). The relevant details of these are shown in Table 3.

The length of time after first exposure to asbestos after which it may be considered justifiable to attribute any death, wholly or in part, to exposure to asbestos is unknown and must therefore be chosen in a largely arbitrary way. We have decided to analyse in greater detail only those deaths in the group studied here which occurred 15 years or more after first exposure to asbestos. As there were relatively few women exposed to risk, this further analysis is confined to men.

Table 4 shows the distribution of deaths by cause in those men workers who had died 15 years or more after they had first been exposed to asbestos, together with, for certain causes, the proportionate mortality figures in this group of workers, and in all men (25-64 years) in south-east Wales during the same period. There is some evidence of an excess in the proportion of deaths due to neoplasms of the lung, bronchus, and pleura, and of deaths due to accidental causes. Deaths due to diseases of the circulatory system also show a slight excess, but there is

*International Statistical Classification of Diseases, Injuries and Causes of Death; World Health Organization, 1957.

TABLE 2

DISTRIBUTION OF DEATHS AT ALL AGES BY SEX AND CAUSE

No.*	Cause of Death	No. of Deaths	
		Males	Females
1, 2	Tuberculosis	8	3
3-9	Other infections	1	
	All infections	9 (8·3)†	3
10	Neoplasms: stomach	3	–
11	lung, bronchus and pleura	12 (11·1)†	–
12, 13	breast, uterus	–	1
14, 15	others	7	1
	All neoplasms	22 (20·4)†	2
18	Coronary disease	14	2
17, 19-21	Other heart & vascular disease	27	2
	All circulatory disease	41 (38·0)†	4
22-25	Bronchitis, etc.	10	–
26-31	Other causes	6	–
32	Ill-defined diseases	3	1
33	Accidents: vehicle	9	–
34, 35	others	8	–
	All accidents (other than war)	17 (15·7)†	–
Total for which cause known (excluding war)		108 (100·0)†	10
Deaths due to war		19	–
Total for which cause not yet known		6	1
Grand total		133	11

*Abridged list of causes of death as used by the R.G.O. for England and Wales.

†Number of male deaths for certain causes shown as a percentage of all deaths for which cause is known (excluding deaths due to war).

TABLE 1

DISTRIBUTION OF POPULATION WITHIN CRITERIA OF STUDY BY SEX, AGE, WHETHER OR NOT TRACED, AND WHETHER OR NOT DEAD

Year of Birth	Total Traced		Dead		Not Traced		Grand Totals	
	Male	Female	Male	Female	Male	Female	Male	Female
1870-	10	—	10 (100)*	— (—)	1 (9)†	— (—)	11	—
1880-	27	3	16 (59)	1 (33)	16 (37)	— (—)	43	3
1890-	73	8	29 (40)	1 (13)	7 (9)	2 (20)	80	10
1900-	161	28	24 (15)	4 (14)	25 (13)	4 (13)	186	32
1910-	304	73	31 (10)	4 (5)	37 (11)	13 (15)	341	86
1920-	327	103	21 (6)	1 (1)	39 (11)	11 (10)	366	114
1930-	103	17	2 (2)	— (—)	11 (10)	1 (6)	114	18
1940+	10	5	— (—)	— (—)	1 (9)	1 (17)	11	6
Unknown	—	—	— (—)	— (—)	1 (—)	— (—)	1	—
Totals	1015	237	133 (13)	11 (5)	138 (12)	32 (12)	1153	269

*Numbers dead shown in brackets as percentages of numbers traced.
†Numbers not traced shown in brackets as percentages of grand totals.

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TABLE 3

DETAILS OF WORKERS WHO HAD DIED FROM MALIGNANT DISEASE OF THE LUNG, BRONCHUS OR PLEURA (I.S.C. 162, 163)

Subject	Date of Birth	First Employed in Asbestos Industry	Duration of Employment in Asbestos (yr.)	Time from First Exposure to Death (yr.)	Age at Death (yr.)	Cause of Death
V.J.	1906	1932	4	21	47	Mesothelioma
H.C.	1905	1935	2	26	56	Carcinoma bronchus
L.W.	1913	1936	1	26	49	Carcinoma bronchus
R.M.	1911	1936	7	25	50	Carcinoma bronchus
E.H.	1899	1939	17	17	57	Carcinoma bronchus
F.C.	1888	1946	1	15	73	Carcinoma bronchus
W.B.	1901	1940	1	19	58	Adenocarcinoma
T.L.	1899	1948	1	14	63	Carcinoma bronchus
W.J.	1887	1950	4	10	73	Carcinoma bronchus
T.V.	1907	1950	1	8	51	Carcinoma bronchus
W.T.	1889	1945	1	7	63	Carcinoma bronchus
E.W.	1877	1941	1	5	69	Carcinoma bronchus

TABLE 4

DISTRIBUTION OF DEATHS AT ALL AGES BY CAUSE, IN MEN WHO WERE ALIVE 15 YEARS AFTER THEIR FIRST EXPOSURE TO ASBESTOS DUST

No.*	Cause of Death	No. of Deaths		
1, 2	Tuberculosis	1		
3-9	Other infections	–		
	All infections	1	(2·3)	(4·5)†
10	Neoplasms: stomach	2		
11	lung, bronchus, pleura	7	(15·9)	(8·1)†
14, 15	others	1		
	All neoplasms	10	(22·7)	(21·7)†
18	Coronary disease	9		
17, 19-21	Other heart & vascular disease	12		
	All circulatory disease	21	(47·7)	(33·7)†
22-25	Bronchitis, etc.	4		
26-31	Other causes	1		
32	Ill-defined diseases	1		
33	Accidents: vehicle	1		
34, 35	others	5		
	Accidents	6	(13·63)	(7·6)†
Total for which cause known		44	(100·0)	(100·0)
Deaths due to war		–		
Total for which cause not yet known		2‡		
Grand total		46		

*Abridged list of causes of death as used by the R.G.O. for England and Wales.

†Proportionate mortality figures for deaths in south-east Wales in all men (25-64 years) in 1952-61.

‡Dates of death not yet ascertained with certainty.

Numbers of deaths for certain causes shown as a percentage of all deaths for which cause is known (excluding deaths due to war).

little evidence of any increase in the proportion of deaths due to all neoplasms.

To examine the mortality in this group more exactly, the numbers of deaths for all causes, for neoplastic diseases, and for diseases of the circulatory system were compared with those expected on the basis of age specific mortality rates in all men in south-east Wales. The period of interest in this context is that subsequent to 15 years after the first exposure of each worker to asbestos dust, and for the majority this is 1951 and following years, though a few workers are known to have been first exposed to asbestos before 1936 and these were therefore 'at risk' during years before 1951. The expected numbers of deaths were calculated by applying age specific mortality rates for men in south-east Wales for each relevant year to the total male population at risk, using a life table technique. For those workers at risk during years before 1951 the same technique was used, but as age specific mortality data are not available for south-east Wales for years before 1951, those for 1951 were used for these years. The expected numbers so calculated, together with those observed, are shown in Table 5. There is no

TABLE 5

OBSERVED NUMBERS OF DEATHS FROM ALL CAUSES, AND FROM CERTAIN CAUSES, IN MEN ALIVE 15 YEARS AFTER FIRST EXPOSURE TO ASBESTOS DUST, AND THOSE EXPECTED ON THE BASIS OF THE MORTALITY DATA FOR S.E. WALES DURING THE SAME PERIOD

I.S.C. No.	Cause of Death	Observed	Expected
400-468	Diseases of the circulatory system	21	17·54
162-163	Neoplasm of lung, bronchus, and pleura	7	3·02
140-239	All neoplasms	10	9·10
	All deaths	46	47·87

evidence of any important excess in the number of deaths from all causes, but there is some evidence of an excess in the observed numbers of deaths due to all neoplasms, neoplasms of the lung and bronchus, and all circulatory causes.

Discussion

This study was planned primarily to ascertain whether or not mesothelioma of the pleura is a common, or a relatively common, cause of death in

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workers who have been exposed to asbestos dust. No evidence has been obtained to suggest that in the group studied this was the case, as only one man, who had died in a local hospital just before the beginning of this study, had died from this cause.

A larger number of men died from neoplasm of the lung or bronchus than would be expected on the basis of the mortality experience of all men in south-east Wales. However, the number of deaths from this cause is very small, and as the smoking habits of those who died are unknown, the importance of the excess found cannot be assessed. However, this finding is in accord with the results of other studies in this field, and furthermore it appears that in the present data, the excess in the number of deaths from this cause more than accounts for an excess in the observed number of deaths from all neoplasms over that expected.

The excess in the observed number of deaths from all circulatory causes is of interest as Mancuso and Coulter (1963) have suggested that there may be an association between asbestosis and mortality from cardiovascular causes, in particular cor pulmonale, and this latter may be entered on the certificate of the cause of death. However, this is unlikely to explain the whole of the excess in the present data as, of the 21 who had died 15 or more years after first exposure to asbestosis from disease of the circulatory system, only five had been exposed to asbestos dust for 10 years or more. Furthermore, in only one case did cor pulmonale appear on the certificate of the cause of death.

The limitations of this study are considerable. Most of the workers involved had been exposed to asbestos for relatively short periods. While this is probably not of importance with regard to the risk of death from pleural mesothelioma (Hourihane, 1964), it is of considerable relevance to that of carcinoma of the lung (Doll, 1955). Nevertheless the apparently low risk of death from pleural mesothelioma is of interest, as it suggests that chrysotile may not be an aetiological factor in this context, particularly as it is not known whether or not the one man who died from this cause had been exposed to crocidolite during the period 1932-35. However, exposure to asbestos is probably unlikely to be a cause, or a contributory cause, of death either from mesothelioma or from carcinoma of the lung for a considerable period after first exposure. In the present study, the majority of the workers have been followed up at a time relatively little in excess of 15 years after their first exposure, and so the total risks of death from these causes may have been considerably underestimated. Only by repeated follow-up studies of the population can these total risks be estimated.

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