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A MORTALITY STUDY AMONG WORKERS IN AN ENGLISH ASBESTOS FACTORY

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This cohort study of workers in an asbestos textile factory in the North of England has been the subject of three previous reports (Doll, 1955; Knox et al., 1965; Knox et al., 1968). These dealt particularly with mortality from lung cancer and respiratory disease in workers exposed to the high dust levels preceding the 1931 Asbestos Industry Regulations, and examined the dependence of lung cancer incidence on age and duration of exposure. The last report, published in 1968, showed little evidence of increased mortality among workers who had entered the factory after the implementation of the 1931 regulations, but pointed out that no firm conclusions could be drawn, as little carcinogenic effect would be expected for 20 years after first exposure. As time is so limited today we shall deal particularly with the post-1932 population which, although initially exposed to dust levels higher than present permitted levels, has an experience more relevant to modern industrial conditions. The results for earlier workers and the dependence of lung cancer incidence on age and exposure will be discussed more fully in a later report.

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RESULTS

The total population is divided into 5 cohorts on the basis of duration and period of work in scheduled (dust risk) areas of the factory (Table 1). Re-examination of personnel records since the last report revealed a further 23 workers eligible for inclusion in cohorts 1 and 2, and 204 who have completed 10 years employment since June 1966

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have been added to cohorts3, 4 and 5. The study population thus comprises 284 women and 831 men, of whom all but 25 (2.3 per cent) have been followed up to the end of 1974.

The numbers of deaths in each group due to lung cancer,* other cancers, respiratory diseases and other causes are compared in Table 2 with the numbers expected from national death rates. Workers first exposed before 1933 (cohorts 1 and 2) suffered a marked excess of lung cancer and respiratory disease, particularly those with 10 or more years' exposure prior to 1933. There is also some excess mortality from lung cancer (35 observed, 19.3 expected; p**=.001) and perhaps respiratory disease (33 observed, 25.4 expected; p=0.08) in those who entered scheduled areas after January 1st 1933 (cohorts 3, 4 and 5 combined), although very much less than in the first two cohorts. To distinguish exposure immediately after 1933 from present conditions these three cohorts were divided into those first entering scheduled areas from 1933 to 1950 and those starting later. 1951 was taken as the start of the 'modern period' because it was the year in which routine dust sampling was initiated, although dust levels in some areas remained high for at least 6 years after this. Observed and expected deaths for those first exposed between 1933 and 1950 and those first exposed later are shown in Table 3. There is clear evidence of some excess of lung cancer and respiratory deaths among those first exposed between 1933 and 1950, although less than in cohorts 1 and 2. The numbers are rather small for those first exposed in 1951 and subsequently, but there still appears to be an excess of deaths due to lung cancer after 15 or more years'

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* Deaths due to mesothelioma of the pleura are included under lung cancer.

** All significance levels give the probability of observing the actual number of deaths or more in a Poisson distribution with the expected mean.

exposure (5 observed, 1.86 expected; p=.04), and the relative risk increases progressively with time since first exposure (Table 4). The six men in this group who died of lung cancer were all smokers, 5 worked in areas where dust levels were high in 1951, and one may have been exposed to asbestos dust from 1925 to 1930 in a previous occupation. Asbestosis was found at post-mortem in two of the six cases.

It is difficult to interpret the relevance of these results to modern conditions. The implementation of the Asbestos Industry Regulations, 1931, started a drive to improve dust control interrupted only by the relaxation of regulations during World War II, when working hours were increased and black-out restrictions interfered with ventilation. Technical improvements over this period included major changes between 1953 and 1957, and dust levels have fallen by approximately 50 to 80 per cent throughout the factory, the largest reductions being in areas where levels were highest in 1951.

The object of this study was to establish the value of technical improvements since 1931, but as there is a delay of 15 or more years between first exposure and any resulting cancer our results may not reflect the effects of working conditions over the last 15 or 20 years. We therefore propose to continue follow-up on those entering scheduled areas since 1951, and subsequent analysis, when the numbers are substantially larger, will focus on the relationship between mortality and dust levels at first exposure. Such estimates will contribute to the establishment of hygiene standards designed to eliminate asbestosis and lung cancer.

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TABLE 1

NUMBER OF WORKERS IN EACH EXPOSURE COHORT

Cohort	Sex	Years in Scheduled Areas	Years in Scheduled Areas Before 1933	Number	Person-Years Observation
1	Male	20 or more	10 or more	69	1,097
2	Male	20 or more	less than 10	74	1,398
3	Male	20 or more	None	263	2,049
4	Male	10-19	None	678*	7,251
5	Female	10 or more	None	284	4,360
Total				1,105	16,155

* Including the 263 men in cohort 3 before they had completed 20 years in scheduled areas.

TABLE 2

NUMBER OF DEATHS OBSERVED AND EXPECTED, BY EXPOSURE COHORT AND CAUSE

Cause of death	Cohort	Observed deaths	Expected deaths	Ratio Observed/ Expected	Probability of observed number or more
Lung cancer	1	15	1.58	9.5	<.001
	2	10	3.05	3.3	.001
	3	9	5.56	1.6	.11
	4	23	12.83	1.8	.01
	5	3	0.92	3.3	.07
Other cancers	1	8	4.72	1.7	.11
	2	3	4.31	0.7	.80
	3	6	6.62	0.9	.65
	4	11	17.89	0.6	.97
	5	6	7.63	0.8	.77
Respiratory	1	14	5.31	2.6	.001
	2	7	4.36	1.6	.15
	3	8	5.93	1.3	.25
	4	21	17.63	1.2	.24
	5	4	1.81	2.2	.11
Other causes	1	27	23.68	1.1	.27
	2	23	18.04	1.3	.15
	3	36	26.58	1.4	.05
	4	72	76.09	0.9	.70
	5	11	13.35	0.8	.78
All causes	1	64	35.29	1.8	<.001
	2	43	29.76	1.4	.01
	3	59	44.69	1.3	.02
	4	127	124.44	1.0	.42
	5	24	23.71	1.0	.50

TABLE 3

NUMBERS OF DEATHS OBSERVED AND EXPECTED, BY DATE OF FIRST EXPOSURE

Cohort	Cause	Observed	Expected	Ratio	Probability of observed number or mo
Men and women first exposed 1933-1950 (n=615)	Lung cancer	29	16.11	1.8	.01
	Other cancers	20	27.11	0.7	.93
	Respiratory	31	22.26	1.4	.05
	Other causes	108	98.99	1.1	.19
Men and women first exposed 1951 or later (n=347)	Lung cancer	6	3.20	1.9	.11
	Other cancers	3	5.03	0.6	.88
	Respiratory	2	3.11	0.6	.82
	Other causes	13	17.02	0.8	.87

TABLE 4

OBSERVED AND EXPECTED DEATHS DUE TO LUNG CANCER BY TIME SINCE FIRST EXPOSURE IN 347 WORKERS FIRST EXPOSED SINCE 1.1.1951

Period Since First Entering Scheduled Area (Years)	Number Contributing To Analysis	Number Of Deaths	Expected Number Of Deaths	Ratio Observed/ Expected	Probability Of Observed Number Or More
<15	347	1	1.34	0.7	0.74
15-20	285	3	1.34	2.2	0.15
Over 20	133	2	0.52	3.8	0.10
Total	347	6	3.20	1.9	0.11