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Mortality of flax workers

P C ELWOOD,[1] H F THOMAS,[1] P M SWEETNAM,[1] AND J H ELWOOD[2]

From the MRC Epidemiology Unit,[1] Cardiff, and the Department of Community Medicine,[2] Queen's University, Belfast, UK

ABSTRACT A total of 2528 workers in flax mills in Northern Ireland were followed up for 16 years. Follow-up was 97% complete. Deaths were identified and date and cause ascertained. Expected deaths were calculated on the basis of age and sex specific rates for Northern Ireland. Both male and female workers had fewer deaths than expected, and mortality showed no clear relationship with type of work. There was a small excess in the mortality of workers who had had byssinosis at the time of the original survey, but there was no evidence that the more severe grades of byssinosis were associated with higher mortality than the less severe grades. Workers who smoke are known to have an increased risk of developing byssinosis, and cigarette smoking may be responsible for most of the excess deaths in the workers with byssinosis.

The vegetable fibre textile industry has declined in the United Kingdom, but it is probable that with the increasing cost of synthetic fibres the industry may now expand.[1] Byssinosis is a respiratory condition that occurs in workers handling cotton, flax, and hemp. The importance of the condition is acknowledged by the fact that in the United Kingdom it is a "prescribed" disease under the Industrial Injuries Act (1965). It is also an important condition in the United States and in developing countries.[2] The long-term effect of these vegetable dusts and of byssinosis on health, however, has been inadequately assessed.[3]

The Northern Ireland flax industry and the dust concentrations of the various processes have been described in detail elsewhere.[4-6] Briefly, the processes may be divided into five groups which vary greatly in their dustiness. "Pre-preparing" includes the dustiest tasks (hackling and carding); "preparing" also includes dusty processes (combing, roving, and doubling); "wet spinning" is a group of tasks in which almost no dust is produced; "other finishing" includes tasks with a wide range of dust concentrations, most of which are lower than preparing. Several tasks, such as machine maintenance, do not fit this classification and are termed "other." If dust exposure of workers does occur in these it is intermittent.

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Byssinosis occurs in workers within all these occupational groups, and its prevalence is related to the dust concentration.[7] The condition, therefore, occurs predominantly in the pre-preparers and preparers, less frequently in other finishers and other workers, and only exceptionally in wet finishers.

The classic description of byssinosis was given by Schilling.[8] It occurs as a tightness of the chest, or dyspnoea, which occurs initially only on Mondays but which, when severe, can occur on every working day. A grading scheme[8 9] is now widely used. This defines occasional Monday symptoms as grade "½," symptoms every Monday as grade "I," and symptoms on days in addition to Monday as grade II.

We report here a long-term follow-up of 2528 workers employed in the flax industry in Northern Ireland who had been first seen in an epidemiological survey conducted in 1961-2.[4 5]

Method

All the workers who had been investigated in the original survey in 1961-2, who had been over 35 at that time, and who worked with flax only (11 mills) or flax and synthetics (8 mills) were followed up. They were traced using a variety of methods, including extensive home visiting. Death or survival of each worker at 31 December 1977 was ascertained and, for those who had died, the date and the certified cause of death was obtained and coded according to the 8th revision of the ICD.[10]

The numbers of expected deaths were calculated by applying age and sex specific death rates for the population of Northern Ireland to person-years at risk as calculated by the Man Years Computor Language.[11] The mortality rates used were the average annual rates for each sex and within five-year age groups for the following three periods of the follow-up: 1961-5, 1966-70, and 1971-7.

It was decided to base our main conclusions on data for mortality from all causes, but deaths attributed to respiratory causes were also examined.

Results

There were 2528 workers aged 35 years or more who had been seen in the 19 mills in the original survey. Over 97% of these were traced, and their survival status at 31 December 1977, 16 years later, was ascertained. The distributions of the workers traced and of those lost to follow-up, subdivided by occupational group and by byssinosis grade at the time of the original survey are presented in tables 1 and 2. Losses to follow-up are small and bias is thus unlikely. Findings are based on the 2465 workers (839 men and 1626 women) who were traced.

Table 3 shows for men, and table 4 for women, the numbers of deaths in the five occupational groups subdivided by smoking habit as recorded at the time of the original survey, and the numbers expected on the basis of age-specific mortality rates in the total male and female population in Northern Ireland during the period of the follow-up. As these last are not available for subgroups defined by smoking habit, it is not possible to standardise the expected numbers for smoking.

All the standardised mortality ratios (SMRs) for the male workers and most of those for the female workers are low. This is the expected "healthy

Table 1 *Numbers of workers traced and numbers lost to follow-up (in parentheses) in male and female workers, grouped by occupation and by smoking habit*

Occupational group	*Non- and ex-smokers*		*1-14 cigs/day*		*≥15 cigs/day*		*All workers*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Pre-preparers	50 (1)	28 (1)	63 (3)	16 (—)	41 (1)	1 (—)	154 (5)	45 (1)
Preparers	31 (1)	444 (10)	44 (1)	160 (5)	26 (—)	15 (—)	101 (2)	619 (15)
Other finishers	45 (—)	420 (8)	64 (3)	121 (1)	31 (2)	12 (1)	140 (5)	553 (10)
Other workers	132 (1)	31 (—)	151 (2)	3 (—)	104 (1)	—	387 (4)	34 (—)
Wet finishers	22 (—)	215 (7)	19 (1)	142 (13)	16 (—)	18 (—)	57 (1)	375 (20)
All workers	280 (3)	1138 (26)	341 (10)	442 (19)	218 (4)	46 (1)	839 (17)	1626 (46)

Table 2 *Numbers of workers traced and numbers lost to follow-up (in parentheses) in male and female workers, grouped by byssinosis grade and by smoking habit*

Byssinosis grade	*Non- and ex-smokers*		*1-14 cigs/day*		*≥15 cigs/day*		*All workers*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
0	251 (2)	1037 (22)	269 (7)	365 (17)	176 (3)	38 (1)	696 (12)	1440 (40)
½	12 (—)	44 (3)	33 (2)	36 (1)	17 (1)	2 (—)	62 (3)	82 (4)
I	12 (—)	37 (—)	18 (—)	27 (—)	13 (—)	4 (—)	43 (—)	68 (—)
II	5 (1)	20 (1)	21 (1)	14 (1)	12 (—)	2 (—)	38 (2)	36 (2)
All workers	280 (3)	1138 (26)	341 (10)	442 (19)	218 (4)	46 (1)	839 (17)	1626 (46)

Table 3 *Observed deaths in men from all causes (O) in occupational subgroups divided by smoking habit, number of deaths expected (E) on the basis of mortality in the total male population of Northern Ireland, and SMRs*

Occupational group	*Non- and ex-smokers*		*1-14 cigs/day*		*≥15 cigs/day*		*All male workers*		
	O	*E*	*O*	*E*	*O*	*E*	*O*	*E*	
Pre-preparers	17	22·5	19	28·2	18	12·1	54	62·8	SMR = 86
Preparers	3	13·4	18	12·0	6	9·3	27	34·7	SMR = 78
Other finishers	16	16·7	18	21·7	9	14·0	43	52·4	SMR = 82
Other workers	42	47·3	47	68·5	29	39·5	118	155·26	SMR = 76
Wet finishers	2	7·4	5	9·3	5	5·8	12	22·5	SMR = 53
All men	80	107·3	107	139·6	67	80·8	254	327·7	
		SMR = 75		SMR = 77		SMR = 83		SMR = 78	

Table 4 *Observed deaths in women from all causes (O) in occupational subgroups divided by smoking habit, numbers of deaths expected (E) on the basis of mortality in the total female population of Northern Ireland, and SMRs*

Occupational group	*Non- and ex-smokers*		*Smokers*		*All female workers*		
	O	*E*	*O*	*E*	*O*	*E*	
Pre-preparers	8	4·9	1	1·7	9	6·6	SMR = 137
Preparers	79	99·1	22	18·5	101	117·6	SMR = 86
Other finishers	60	92·6	16	18·5	76	111·0	SMR = 68
Other workers	3	10·2	1	0·4	4	10·7	SMR = 38
Wet finishers	32	45·7	26	18·6	58	64·3	SMR = 90
All women	182	252·4	66	57·7	248	310·1	
		SMR = 72		SMR = 114		SMR = 80	

worker effect"—that is, workers who are seen in any survey are selected by the fact that they are working and will subsequently show a lower mortality than the total population, which includes sick and disabled subjects.[12 13] In fact, close examination of our data shows that this healthy worker effect diminishes during successive periods of time within the follow-up period, as would be expected on this hypothesis. In the first five years the SMRs for all causes of death for all workers were 56 in men and 53 in women, in the second five years 72 and 70, and in the most recent period of seven years 87 and 91.

The data in tables 3 and 4 give no consistent evidence suggestive of a higher mortality in the more dusty occupations. Among men the differences between the SMRs are small and cannot reasonably be taken to represent any effect other than chance. Among women differences are larger but account must be taken of the fact that both the highest SMR (137 in pre-preparers) and the lowest (38 in other workers) are based on small numbers of observed deaths. In fact, if the two most dusty groups, pre-preparers and preparers, are combined then their SMR (88) is comparable with that of the least dusty group, wet finishers (90).

The same data for the workers subdivided by byssinosis grade at the time of the original survey are shown in tables 5 and 6. There are pronounced fluctuations in the SMRs, but there is no trend in either sex of an increasing SMR with increasing grades of byssinosis. The sum of the three grades (½, I, and II), however, yield an SMR for men of 100 and for women of 103, both of which are higher than the SMRs for the workers who had had grade 0—that is, no symptoms of byssinosis (73 in men and 78 in women).

Table 5 *Observed deaths in men from all causes (O) by byssinosis grade, subdivided by smoking habit, numbers of deaths expected (E) on the basis of mortality in the total male population of Northern Ireland, and SMRs*

Byssinosis grade	*Non- and ex-smokers*		*1-14 cigs/day*		*⩾15 cigs/day*		*All male workers*		
	O	*E*	*O*	*E*	*O*	*E*	*O*	*E*	
0	72	95·5	79	113·0	50	66·0	201	274·5	SMR = 73
		SMR = 75		SMR = 70		SMR = 76			
½	4	4·7	13	11·4	7	5·7	24	21·7	SMR = 111
I	2	4·9	6	5·8	3	4·7	11	15·4	SMR = 71
II	2	2·2	9	9·4	7	4·5	18	16·1	SMR = 112
½ + I + II	8	11·8	28	26·6	17	14·9	53	53·2	SMR = 100
		SMR = 68		SMR = 105		SMR = 114			
All men	80	107·3	107	139·6	218	80·8	254	327·7	SMR = 78

Table 6 *Observed deaths in women from all causes (O) by byssinosis grade, subdivided by smoking habit, numbers of deaths expected (E) on the basis of mortality in the total female population of Northern Ireland, and SMRs*

Byssinosis grade	*Non- and ex-smokers*		*Smokers*		*All female workers*		
	O	*E*	*O*	*E*	*O*	*E*	
0	162	232·6	55	47·4	217	280·0	SMR = 78
		SMR = 70		SMR = 105			
½	10	7·1	6	5·0	16	12·1	SMR = 132
I	5	7·4	4	3·3	9	10·7	SMR = 84
II	5	5·3	1	2·1	6	7·3	SMR = 82
½ + I + II	20	19·8	11	10·4	31	30·1	SMR = 103
		SMR = 101		SMR = 106			
All women	182	252·4	66	57·7	248	310·1	SMR = 80

Table 7 *Observed deaths from respiratory causes (O) in occupational groups, in men and in women, the numbers of deaths expected (E) on the basis of mortality in the total population of Northern Ireland, and SMRs*

Occupational group	*All male workers*			*All female workers*		
	O	*E*		*O*	*E*	
Pre-preparers, Preparers	16	12·0	SMR = 133	5	10·3	SMR = 49
Other finishers, Other workers, Wet finishers	23	28·6	SMR = 80	8	15·4	SMR = 52
All workers	39	40·7	SMR = 96	13	25·8	SMR = 50

Table 8 *Observed deaths from respiratory causes (O) by byssinosis grade, the numbers of deaths expected (E) on the basis of mortality in the total population of Northern Ireland, and SMRs*

Byssinosis grade	*All male workers*			*All female workers*		
	O	*E*		*O*	*E*	
0	31	34·2	SMR = 91	10	23·4	SMR = 43
½	1	2·6		1	1·0	
I	2	1·8		2	0·8	
II	5	2·0		0	0·6	
½ + I + II	8	6·4	SMR = 125	3	2·4	SMR = 125
All workers	39	40·7	SMR = 96	13	25·8	SMR = 50

In an attempt to clarify the evidence relevant to the hazard of exposure to flax dust, and the risk to life of byssinosis, we examined those deaths certified as due to respiratory causes. The numbers of these were small, 39 in men and 13 in women, so the analysis is limited. Table 7 shows that the pattern is inconsistent in the two sexes and while the SMR is higher in male preparers than in male non-preparers, there is little difference in the female workers. Table 8 shows the same data for the workers divided by byssinosis grade. Numbers are too small for confident interpretation, and although there were slightly more respiratory deaths in workers with byssinosis than expected, the excess is small. This excess, allowing for the low SMR in the non-byssinotic workers, appears to be equivalent to perhaps two respiratory deaths in each sex.

Discussion

We report a follow-up study of workers who had been seen in 1961-2 in the flax preparing and spinning industry in Northern Ireland. In the original survey it was estimated that about 83% of the total work force handling natural fibres had been seen. The present follow-up, 16 years later, is 97% complete. It is therefore most unlikely that our results could be seriously biased through selection.

In the original study byssinosis was found to be common in the early stages of the industry, namely pre-preparing and preparing and much less common in the other occupational subgroups. There was no pronounced association between prevalence and age, though the data did suggest that the severity of the symptoms may have increased with increasing age. There was a definite association between smoking habit and the occurrence of byssinosis, with prevalence rates of byssinosis about twice as high in smokers as in non-smokers in most age and sex subgroups.

The data we now present give little support to the hypothesis that exposure to flax dust affects survival. There is no consistent evidence that the workers who had been exposed to the highest dust concentrations experienced a higher mortality than other workers. This is perhaps surprising as the dust concentrations generated in the early stages of flax preparing are very high indeed.[6]

The evidence relating to the mortality of workers who had had byssinosis at the time of the original survey is much more difficult to interpret. The association between the occurrence of byssinosis and smoking habit is apparent in table 2, which shows that of workers without byssinosis (grade 0) 64% of men and 28% of women are smokers, whereas of the byssinotic workers 80% of men and 46% of the women smoked. It is unfortunate, therefore, that the "expected" numbers of deaths, which we derived from mortality rates in Northern Ireland during the period of follow-up, could not be standardised for smoking habit. It is to be expected therefore that the SMRs for byssinotic workers will be higher than the SMRs for non-byssinotic workers, but the proportion of these differences that is explained by the higher smoking rates in the byssinotic workers cannot be reliably estimated.

For this reason it is difficult to interpret the results summarised in tables 5, 6, and 8. The effect of smoking is inconsistent in the two sexes, and while the SMRs in workers who had had byssinosis are greater than those in non-byssinotic workers, in absolute numbers the excess deaths are few. There is no suggestion of any increase in the excess with increasing grades of byssinosis. We consider that this last point is important as one would reasonably expect a relationship, and its complete absence in both sexes, both for total deaths and for deaths from respiratory causes, strongly suggests that even if there is an excess occupational mortality associated with byssinosis, it is likely to be very small, and again could be a consequence of smoking.

Our findings are consistent with a 12-year follow-up study of cotton workers in which there is no evidence relating mortality to the presence of byssinosis.[14]

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