DUST DISEASES IN DUNDEE TEXTILE WORKERS

AN INVESTIGATION INTO CHRONIC RESPIRATORY DISEASE IN JUTE AND FLAX INDUSTRIES

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(RECEIVED FOR PUBLICATION FEBRUARY 1, 1960)

A survey of respiratory symptoms and function was carried out in Dundee among 123 men and women in the jute industry and 242 in the flax industry. The selection of workers was biased in favour of those working in the dustier departments as judged by eye and those in the older age groups. A group of 72 men in a heavy engineering firm were also selected as controls for comparison.

Chronic bronchitis, as defined by Ogilvie and Newell (1957) was recorded in 27% of those interviewed, whose average age was 49. Byssinosis of various grades was recorded in 30% of all working in flax; of these 35 had cough alone worse on Monday, 34 had other respiratory symptoms worse on Monday and in only four persons did the exacerbation persist longer in the week.

In spite of the occurrence of byssinosis, chronic bronchitis was no more prevalent among flax workers than among the others, the average ventilatory function was no worse, and radiographs of the chest revealed no differences. The characteristic fall in expiratory flow rate during the course of exposure to flax dust on Mondays is similar to that found in cotton workers, and is absent in jute workers and in flax workers not admitting to symptoms of byssinosis.

During the 18th and 19th centuries attention was drawn to the prevalence of cough and asthma in hemp, flax, and cotton industries (Ramazzini, 1700; Patissier, 1822; Thackrah, 1832). Reference to exacerbations of respiratory symptoms in employees in such trades on Mondays (now referred to as Monday fever) was made by Greenhow (1862). Confirmation of these findings is found in recent publications (Werner, 1955; Doig, 1956), while Schilling (1956) in his Milroy Lectures has reviewed the literature of byssinosis in cotton workers in the Lancashire mills.

Another textile industry producing dust is the manufacture of jute, of which little or nothing is yet known about the respiratory effects, although brief reference has been made to it by Arlidge (1892) and Schilling (1956). While this study was designed to prove the presence or absence of dust disease in jute workers, it was found useful in the course of the investigation to make comparisons with workers in flax.

Historical

Jute is a vegetable fibre which has been cultivated in India for 2,000 years, in areas now known as East Pakistan and Indian Bengal. There are two types of jute fibre, *Corchorus capsularis* and *C. olitorius*, which are annual plants with long, erect, thin stems growing to a height of 10-12 ft. or more (Macmillan, 1935). Harvested after four to six months, usually in the period July-October, jute is then subjected to the process of "retting" which involves steeping the plants in stagnant streams or ponds for periods up to a few weeks. Retting separates out the fibres which lie between the central wooden core and outside bark. Jute fibres are then dried in the sun and classified according to colour, strength, and fineness. Since it was first imported from India some 140 years ago, the manufacture of jute in Great Britain has been largely concentrated in Dundee and district. Before this, the chief textile was flax, which was both grown and manufactured in this area. Gradually, however, jute has

replaced flax in importance, until only two flax firms now remain, compared with approximately 50 jute firms operating within the city alone.

The processes in the manufacture of jute are largely those of any other textile industry although terminology may differ; the initial processes of batching, preparing, carding, and roving are carried out in the "mill", while spinning, cop and spool winding, weaving, and finishing are done in the "factory". In general terms, and within each firm, the "mill" is considered to be dustier than the "factory".

The Investigation

In all, 437 employees were included in the study. While our concern was primarily the existence or otherwise of dust disease in jute workers, employees from a flax and an engineering firm were included to provide comparative data from dusty and non-dusty conditions respectively. In order to find workers who had been exposed for lengthy periods in dusty occupations, the initial selection was of all males aged 40 years and over working in the mill sections of jute and flax works, where the dustiest processes of "preparing" take place.

In addition, systematic sampling from lists of names, provided by the management, was carried out among workers aged 40 and over, including women, working in other departments of flax and jute factories, and the same method of selection was used for men in the engineering works. The proportion chosen varied inversely with the size of the department, being as low as 1 : 8 for some large weaving flats. A small group of younger workers was also included at a later visit to the flax mill.

TABLE 1

	Number Interviewed			Average Age in Years	
	Male	Female		Male	Female
Jute	87	36	123	51	49
Flax					
Mill (1st visit)	62	20		52	49
(2nd visit)	35	31		32	36
Factory	60	34	242	54	51
Engineering	72	—	72	52	—
Totals	316	121	437	50	48

All 437 subjects (316 men and 121 women) were interviewed using a standard questionnaire,* when both an occupational and symptomatic history were taken, the latter by the same doctor (D.H.S.) throughout the survey.

* The standard questionnaire used was similar in all main essentials to that which was being prepared by the M.R.C. Committee on the Aetiology of Chronic Bronchitis.

Male subjects who admitted to certain symptoms suggestive of respiratory disease, and about a third of males who did not, 153 in all, were subjected to a physical examination (W.L.) limited to the respiratory and cardiovascular systems (see Table 2). No physical examination was carried out in women.

TABLE 2
PROCEDURE

		No. of Subjects
(1) Interview with occupational and symptomatic history		437
(2) Clinical examination (for males only)		153
(a) selected on account of history	115	
(b) random selection	38	
(3) Ventilatory function tests (both sexes)		202
(a) selected on account of history	150	
(b) random selection	52	
(4) Comparative tests on Mondays and Thursdays		22
(a) in flax workers	14	
(b) in jute workers	8	
(5) Radiological examination of matched groups		78
(a) jute workers	24	
(b) flax workers	30	
(c) engineering workers	24	

In addition, all those employees both male and female with a similar history of respiratory symptoms, and a sample of those who had none (202) performed certain ventilatory function tests.

Final steps in the investigation concerned the study of ventilatory function in eight jute and 14 flax workers and the comparative radiological study of 78 employees in the three industries.

Results of the Investigation

Uncertain of what clinical or radiological findings might emerge, we proceeded on the basis of symptoms to make a final assessment and diagnosis of any one or more of several respiratory diseases. Of these, four groups or categories were considered relevant, and among the 437 employees the following were diagnosed (see Table 3).

Chronic Upper Respiratory Catarrh.—This condition, characterized by persistent stuffiness of the nose and constant hawking, was diagnosed in 161 individuals.

Chronic Bronchitis.—The definition of Ogilvie and Newell (1957)* was adopted. Chronic bronchitis of the "simple" variety was considered to be present in 88 subjects, while "complicated" bronchitis was found in 31.

* Definition: Chronic bronchitis is a long standing condition, the essential features of which are cough with sputum persistent through the winter or throughout the year in the absence of other causative respiratory disease. A minimum duration of two years is essential.

TABLE 3
DIAGNOSIS BASED ON SYMPTOMS (Standard questionnaire)

Diagnosis	No.
Chronic upper respiratory catarrh	161
Chronic bronchitis:	
Simple (cough and sputum for at least two years)	88
Complicated (cough and sputum for at least two years with breathing difficulties)	31
Cough worse on Monday only	35
Byssinosis:	
Grade I—Tightness in chest and/or breathlessness on Monday only	34
Grade II—Tightness in chest and/or breathlessness on Monday and other days	4

Byssinosis.—This condition Grade I as defined by Schilling, Hughes, Dingwall-Fordyce, and Gilson (1955) was diagnosed in 34 subjects, while an additional four were found to have the condition described as Grade II. None of these 38 persons was employed in jute; all were flax workers. On the basis, therefore, of these generally accepted definitions and adopting diagnoses based on symptoms and history, there appears to be no byssinosis in jute workers, but symptoms of a mild form of byssinosis among flax workers.

Monday Cough.—In addition to these categories of chronic bronchitis and byssinosis as defined, a different and distinct symptom group became apparent, consisting of 35 individuals who gave a history of "cough alone worse on Monday". No jute employees were in this group; all were employed in flax, although we found two jute workers who did give equivocal histories of "cough worse on Mondays". The clinical histories of these two employees are as follows:

CASE 112.—Jute worker, age 51, with a history of textile dust exposure for eight years (flax four, jute four), had cough, sometimes worse on Monday night (works on night shift). He had been employed in flax as well as jute.

CASE 115.—Jute worker, age 53, with a history of textile dust exposure for seven years (flax four, jute three), had no cough, but admits to slight sputum on Monday. He had worked in flax as well as jute.

Although now employed as jute workers, each had previously worked for four years in flax.

"Chronic bronchitis" may lack precision as a pathological diagnosis, but its value in clinical and epidemiological work is undoubted. Moreover, the chronic effects of vegetable dusts are not easily distinguishable from non-occupational bronchitis (Hunter, 1957). Since grouping as bronchitis might well conceal an undue prevalence of dust disease in jute workers, an attempt was made to unmask any such effect by comparing the prevalence of chronic bronchitis as between one industry and another (see Table 4) in employees 40 years of age and over.

In all three industries, a total of 82 (29%) men were diagnosed as having chronic bronchitis, whereas only 14 (14%) women employees had these symptoms; this difference is highly significant statistically ($p = .001$). Differences between industries, dusty and non-dusty, were not significant. Differences in the three industries again were not significant, the mean percentage prevalence in male jute workers being 36% compared with 22% among males in flax, while engineering employees in non-dusty work held an intermediate position of 34%. The low figure of 22% in flax may be accounted for by the fact that there were fewer smokers in flax than in jute workers.

TABLE 5
ALL WORKERS CLASSIFIED BY YEARS OF EXPOSURE TO DUST

Years of Exposure	Numbers of Workers
Nil	34
< 9	91
9—	80
19—	109
29—	76
39—	47
Total workers in Survey	437

Dust Exposure.—In order to ensure sufficient numbers with lengthy dust exposure, the initial selection of employees was largely limited to those aged 40 years and over. Our objective in so doing (see Table 5) appears to be well nigh achieved. All

TABLE 4
CHRONIC BRONCHITIS IN WORKERS AGED 40 AND OVER

Industry	Males				Females			
	No. in Group	Mean Age (Years)	With Bronchitis		No. in Group	Mean Age (Years)	With Bronchitis	
			No.	%			No.	%
Jute—Firm A	25	51	10	40	25	49	3	12
Firm B	58	51	20	34	11	52	1	9
Flax—Mill	67	52	11	16	30	52	5	17
Factory	58	55	17	29	34	51	5	15
Engineering	70	53	24	34	—	—	—	—
Total	278	53	82	29	100	51	14	14

TABLE 6
BYSSINOTIC SYMPTOMS AMONG FLAX WORKERS

Symptoms	No. of Years of Exposure to Dust					Total
	0—	10—	20—	30—	40—	
Monday cough	7	9	9	5	5	35
Byssinosis—Grade I	8	8	9	5	4	34
Grade II	0	1	2	1	0	4
Total no. with symptoms	15	18	20	11	9	73
Total no. of workers at risk	59	50	53	45	35	242
Expected no. with symptoms of uniform proportion	17.8	15.1	16.0	13.5	10.6	73

NOTES: Chi-squared 2.7; degrees of freedom 4; probability of arising by chance between 0.7 and 0.5

workers, textile and engineering, are included as 38 out of 72 engineering employees had previously worked in jute for short periods.

There are 232 employees with over 20 years' exposure. The relatively large number, 91, with less than nine years' exposure, contains most of the engineering workers with brief exposure. Those 59 examined at the second visit to the flax firm were 39 years of age or less. Both reasons would account for a considerable proportion of employees with less than 20 years' dust exposure. In Table 6 byssinosis Grades I and II are shown in relation to years of dust exposure.

It is common for workers to move from one firm to another, or from one industry to another. Thus more than half of the workers examined in the engineering firm had worked in jute, and to a much less extent flax, at some time in the past; and many of those now working in flax had also worked in jute in the past.

The development of symptoms of byssinosis or of "cough worse on Monday" appears to be unrelated to length of time of exposure to flax dust, and cases were found among those who had worked only a few months in flax. In Table 6 the distribution of workers with these symptoms among the workers with various lengths of dust exposure is in good agreement with the expected numbers, based on the total number of persons in each group.

Dust Counts in Jute.—Dust counts with a Kotze koniometer were attempted, but the results were not considered sufficiently reliable. We were

fortunate in having the advice of an expert with experience in cotton and other industries (Mr. S. A. Roach). He considered, from visual impressions, that even the dustiest departments in jute compared favourably with other textile processes. Using a Hexhlet dust sampler in the batching department of one of the jute firms, he obtained a dust sample with the following composition:

Size of Dust	Jute Firm "A"—Batching Department Concentration (mg./100 cu. m.)			
	Cellulose	Plant Debris	Minerals	Total
Fine	14	4	13	31
Medium	40	11	87	138
Coarse	191	35	152	378
Totals	245	50	252	547

These findings confirm earlier visual impressions and compare favourably with conditions in the carding rooms of cotton mills where the total dust count may reach figures of 900 mg./100 cu. m. total dust (Roach and Schilling, 1960).

Ventilatory Function Tests.—Tests of forced expiratory volume (Table 7) were performed on all workers with histories suggesting respiratory disease together with a sample of those with none, in order to assess their degree of ventilatory disability. The tests were not employed primarily to compare industries but as a means of detecting individuals with respiratory disability in our search for any deleterious effect of dust. The two conditions upon which our interest was mainly focused were byssinosis and chronic bronchitis.

TABLE 7
AVERAGE VENTILATORY FUNCTION OF WORKERS IN DIFFERENT FACTORIES

	Jute		Flax		Engineering	Total
	Firm A	Firm B	Firm C		Firm D	
			Mill	Factory		
No. tested	31	37	43	50	41	202
Average indirect M.B.C./predicted M.B.C. %	83.3	80.3	78.1	84.1	83.7	82.0

A large proportion of the persons tested were selected because of having respiratory symptoms and so were not representative of the industry from which they were chosen. The mean values of ventilatory function given in Table 7 therefore tend to be too low, but it is believed that any difference between the factories would have been accentuated by this method of selection. If any factory did, in fact, have more persons with respiratory disability, a larger proportion of such persons and fewer normal persons would have been selected. As a result, the mean value of ventilatory function tests of employees in each industry is depressed and the difference between results in such industries accentuated. Even with this bias, differences between industries were not significant.

The instrument used was a spirometer of the type described by Bernstein, D'Silva, and Mendel (1952). From the ink tracing the 0.75 second forced expiratory volume F.E.V._{0.75} was measured and the best of three readings selected. In order to reduce the differences between the sexes and the effect of age and body build, the ratio of the indirect maximum breathing capacity or M.B.C. (Kennedy, 1953) to the predicted value of the maximum breathing capacity (Needham, Rogan, and McDonald, 1954) was used.

The standard deviation for this ratio in the whole series was 22.9% so that the fluctuations from factory to factory are no more than would be expected by chance, and there is no indication that the general level of ventilatory function would be less in one industry compared with the others.

TESTS OF VENTILATORY FUNCTION IN JUTE AND FLAX WORKERS.—When it became evident in the course of our survey that there was an appreciable prevalence of byssinosis in flax workers, it was decided to ascertain whether the ventilatory function of these subjects with byssinosis reacted in a similar manner to that of cotton workers with this disease (McKerrow, McDermott, Gilson, and Schilling, 1958). In such event would jute workers behave similarly?

Seven flax workers with byssinosis and seven without byssinosis were compared. Tracings of the forced expiratory volume were made on a "Mendel" type spirometer three times during the day on Monday and on Thursday—7.30 a.m., 11 a.m., and 4.30 p.m. At a later date eight jute workers were investigated in a similar manner, but using a modified Gaensler (1951) spirometer (McKerrow, McDermott, and Gilson, 1960). The results are shown in Fig. 1.

An attempt was made to match the subjects investigated, half being as normal as possible, and half being disabled by respiratory disease.

The fall on Monday in the F.E.V._{0.75} of byssinotics (0.42 l./min., S.E. = 0.13) is just significant, whereas the fall on Thursday is smaller (0.25 l./min.) and fails to reach the level required for statistical significance at the P.05 level. Among jute workers and non-byssinotic flax workers the changes are far less obvious.

Radiological Examinations.—While it is known that in the absence of fibrosis there are no characteristic radiological findings in byssinosis of cotton workers (Hunter, 1957) we had no knowledge of whether the jute dust did in fact possess any fibrogenic qualities on inhalation. Apart from vegetable dust, a considerable amount of mineral dust is also shaken out in the early processes of batching and preparing. Chest radiographs were therefore taken of 78 men, 40 years of age and over, a third from each industry who were known to have worked only in their respective industries. Half of them in each industry had marked histories of respiratory disease and half had none. One lateral and two postero-anterior films were taken, developed under standard conditions and technique (Fletcher, Mann, Davies, Cochrane, Gilson, and Hugh-Jones, 1949) and were read by seven observers who were unaware of the identity of each film. Particular attention was paid to findings which might suggest the earliest phases of pneumoconiosis, the presence or effect of dust, stages of reticulation, or increase in non-vascular pattern of the lung. This part of the investigation was essentially negative. No radiological changes were found which could be accounted for by differences between industries.

In addition to our main interest in dust disease among jute workers, we also sought any relationships between abnormalities of the nasal sinuses and diseases of the chest, but no such relationship was found.

Discussion

The description of respiratory disease in textile workers a 100 years ago is a striking and arresting one. The workers "are seen at a glance to be short-breathed; their rounded shoulders, emaciated frames, prominent eyes and laborious wheezing respiration, all clearly show that they suffer habitually from dyspnoea" (Greenhow, 1862). Asthma, according to the New Statistical Account of Scotland (1845) was endemic in Dundee. By contrast, in the present survey not a single textile worker among the 314 interviewed complained of asthma. Ventilatory function in textile workers is equal to that of engineers, and symptoms of chronic bronchitis are no more frequent.

Men working in jute attracted attention by their

FIG. 1.—Changes in ventilatory function on Mondays and Thursdays. — Monday; - - - Thursday.

poor physique, and rather more of them were found to have dyspnoea of severer grades. This could be attributed to other conditions (spinal, skeletal, or heart disease) and to the recruitment as unskilled labour of partially incapacitated workers.

The finding of byssinosis among flax workers was the only respiratory condition associated with the textile industries investigated by us in Dundee, and invites comparison with byssinosis among cotton workers as described by Schilling *et al.* (1955). Although the general picture is similar, with tightness of chest, breathlessness, and respiratory disability worse on Monday, and a small proportion of workers continuing to be disabled on Tuesday and other days of the week, yet there are differences which may prove to be important in throwing light on the mechanism of byssinosis in various industries.

(1) Cotton workers are more prone to develop byssinosis if they work in the card-room or blow-room; this applies, in particular, to strippers and grinders (Schilling, 1956); by contrast, byssinosis occurs in all departments of the flax mill and factory studied by us. This finding is in agreement with the opinion of those working in the industry, and our

own visual observations, that fine dust floating in the air is found throughout the flax process, right up to the finishing stage.

(2) Byssinosis in flax workers appears to be independent of length of time of exposure to flax dust, and was found in persons with only a few months exposure. Schilling *et al.* (1955) found more byssinosis among cotton workers who had worked 10 years or more in the industry; this was not found by us in flax.

(3) So far no evidence has been found that byssinosis in flax workers produces any serious disability, and it seems to be a milder disease than in cotton workers. Only 10% of flax workers with byssinosis were in Schilling's Grade II, compared with 40% of the cotton workers reported by him (Schilling *et al.*, 1955). No significant reduction in ventilatory function could be demonstrated in flax workers with byssinosis when comparing groups in whom other disease conditions such as chronic upper respiratory catarrh, simple bronchitis, and complicated bronchitis are equal, whereas in cotton workers the ventilatory function is reduced. Dyspnoea of Grade III or worse was found in only

one flax worker with byssinosis (a woman) out of a total of 38 persons affected; in cotton workers the percentage varied from 8 to 25 according to the day on which the workers were interviewed (Schilling *et al.*, 1955).

The relationship of byssinosis to chronic bronchitis is obscure. In cotton workers a clear distinction was postulated between bronchitis, where cough is made worse by exposure to undue concentrations of any dust on any day of the week, and byssinosis, where symptoms are worse following exposure to cotton dust on Monday. In flax the situation is complicated by a group of workers whose cough is the only respiratory symptom worse on Monday, but who do not qualify for diagnosis as byssinosis otherwise.

The possibility of exposure to flax dust giving rise to bronchitis or to symptoms masquerading as bronchitis must be considered. This is unlikely, since the proportion of workers diagnosed as having chronic bronchitis was lower in the flax industry than in the other two industries studied. The comparison is complicated by a higher proportion of non-smokers in the flax industry; possibly the inhalation of flax dust may discourage smoking.

Briefly, therefore, certain flax workers diagnosed as suffering from byssinosis seem to differ both in severity of symptoms and length of dust exposure from cotton workers with byssinosis. This finding and the presence of a group of flax workers whose cough is worse on Monday will require further study and elucidation.

We are particularly indebted to the management of

the four firms and to the employees who cooperated so wholeheartedly.

We are also grateful to Dr. C. Pickard, Consultant Radiologist, and his staff, Royal Infirmary, Dundee, who very kindly provided us with radiological advice and services.

The services and expert advice of Mr. S. A. Roach in matters appertaining to dust analysis have been of much help.

This investigation was carried out with the generous financial assistance of the Chest and Heart Association.

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