SAFE LEVELS OF DUSTINESS IN COTTON SPINNING MILLS

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INTRODUCTION

In the three years 1957–9, over 900 workers in the English cotton industry were awarded disability pensions for byssinosis[1]. With some 14,000 at risk in the dusty processes, such a high incidence of disabling disease indicates that better dust control is needed.

A survey was made in 5 mills with the main object of determining safe levels of dustiness[2].

METHODS

Clinical diagnosis

The clinical history of respiratory symptoms was used to estimate the prevalence of byssinosis. The workers were graded by their histories as follows:—

Grade 0: no symptoms of chest tightness or breathlessness on Mondays;

Grade 1/2: occasional chest tightness on Mondays, or mild symptoms such as irritation of the respiratory tract on Mondays;

Grade 1: chest tightness and/or breathlessness on Mondays only;

Grade 2: chest tightness and/or breathlessness on Mondays and other days.

Detailed occupational histories were also recorded for each worker.

DUST MEASUREMENT

Dust concentrations were measured by a method which could later be used by the cotton mills to check dust levels in their workrooms. The method had to be simple and not too laborious.

Since the finest particles which are deposited in the alveoli have been assumed to give rise to byssinosis[3-5], the concentration of this very fine dust was also measured.

The apparatus used was a modification of the hexhlet described by Wright[6]. Air is drawn at a constant flow rate through a filter paper which is dried and weighed before and after each sample is taken. The difference in weight gives the weight of dust collected. Each sampling apparatus had two hexhlets running in parallel. One had a horizontal elutriator which separated off particles with a falling velocity more than that of a unit density sphere 7μ in diameter. The filter paper in this hexhlet collected only particles below this size. The other hexhlet measured the concentration of all the dust.

THE MILLS STUDIED

Three of the mills studied were spinning low-grade coarse cotton mostly from America and Nigeria, and the other two were spinning high-grade fine

cotton from Sea Island and the Sudan. Their conditions had not changed substantially for twenty-five years. The populations studied included all the card room workers, and the spinning room operatives over the age of twenty-five years in the three mills spinning coarse cotton. The spinning rooms are not regarded as dusty and those who work there are not eligible for compensation. Of the 969 operatives at risk, 96 per cent were seen and graded for byssinosis.

The dust samples were taken as near as possible to the worker and each sample lasted for the whole shift. Altogether 722 working points were sampled.

RESULTS

In the coarse mills, 51 per cent of the card room workers and 2 per cent of the spinning room workers had symptoms of byssinosis. The proportion of card room workers affected in the fine mills was 6 per cent (*Table 1*). Within the card rooms, the nearer workers were to the carding engines the higher was the prevalence of disease (*Table 2*).

There was a wide range of dust concentrations in all the workrooms, but generally the concentrations of dust were higher in the coarse than in the fine

Table 1. Prevalence of byssinosis in coarse and fine mills

	Coarse mills						*Fine mills*		
	Card room workers			*Spinning room workers*			*Card room workers*		
	Number graded		*Proportion with byssinosis* (%)	*Number graded*		*Proportion with byssinosis* (%)	*Number graded*		*Proportion with byssinosis* (%)
	0	*Byssinosis (all grades)*		0	*Byssinosis (all grades)*		0	*Byssinosis (all grades)*	
Men	19	33	63	45	5	10	52	4	7
Women	116	109	48	351	4	1	152	9	6
Total	135	142	51	396	9	2	204	13	6

Table 2. Prevalence of byssinosis in card room workers*

Place of work	*Coarse mills*			*Fine mills*		
	Number graded		*Proportion with byssinosis* (%)	*Number graded*		*Proportion with byssinosis* (%)
	0	*Byssinosis (all grades)*		0	*Byssinosis (all grades)*	
At carding engines	53	80	60	25	7	22
Partly at carding engines	24	24	50	10	0	0
Elsewhere in card room	58	38	40	169	6	3
Total	135	142	51	204	13	6

The figures in this table differ from those in a later analysis of these data[2] in which we excluded card room peratives in more than one position.

Table 3. Airborne dust concentrations in card and spinning rooms

Sampling position	*Coarse mills*		*Fine mills*	
	Dust concentration (mg/100m³)		*Dust concentration* (mg/100m³)	
	Mean	Range	Mean	Range
At carding engines	500	110–1370	320	60–660
Near carding engines	350	170–700	130	50–210
Distant from carding engines	330	80–810	50	10–140
Spinning rooms	150	30–350	Not measured	—

mills and higher near the carding engines than in other positions in the card room (*Table 3*).

DISEASE AND DUST CONCENTRATIONS

First, the relationship between disease and dust concentration was examined in 9 workrooms in which there were altogether 266 workers who had spent 95 per cent or more of their employment in one or other of these rooms. The mean concentration of dust in each of these rooms was calculated.

As shown in *Figure 1*, the prevalence of byssinosis in these rooms was related to the dust concentration. However, there was a poor relationship

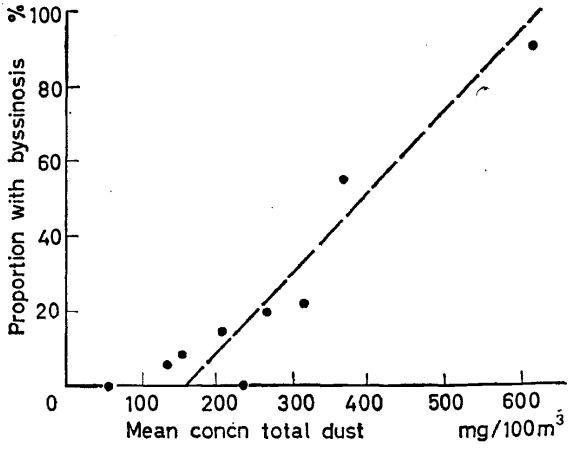

Figure 1. Total airborne concentration of dust and prevalence of byssinosis

between prevalence of byssinosis and the concentration of fine dust, *i.e.* particles less than 7μ (*Figure 2*). Thus, the fine dust by itself does not appear to be a reliable index of the risk of getting clinical symptoms of byssinosis. Therefore, the concentration of all the dust was used as the index for safe levels.

After excluding those who had been exposed to dusts in other trades or

who had spent more than 5 per cent of their time in cotton in other mills, there were 458 whose experience lay in environments where the dust concentrations had been measured. Their years of exposure and corresponding average concentrations are summarized in *Table 4*. This gives the number of workers and how many of them had symptoms of byssinosis (Grade 1 and 2).

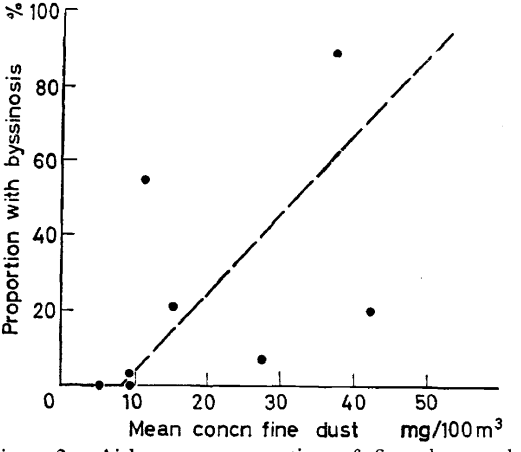

Figure 2. Airborne concentration of fine dust and prevalence of byssinosis

Table 4. The proportion of workers with byssinosis grouped by duration of exposure and concentration of dust: (byssinosis Grades 1 and 2 only)

Duration of exposure (years)	*Prevalence of byssinosis Grades 1 and 2*	*Concentration of dust* (mg/100m³)			
		0–	100–	250–	500+
0–	No. with byssinosis	0	0	6	3
	No. in group	14	82	31	7
5–	No. with byssinosis	0	2	7	4
	No. in group	17	34	17	7
10–	No. with byssinosis	0	5	19	4
	No. in group	23	57	41	8
20–	No. with byssinosis	0	5	5	1
	No. in group	18	41	7	1
30+	No. with byssinosis	0	5	3	0
	No. in group	9	35	8	1
Total	No. with byssinosis	0	17	40	12
	No. in group	81	249	104	24

Amongst those exposed to an average concentration of more than 250 mg/100 m^3, there was a high proportion with byssinosis, even when the period of exposure was short. Clearly, dust control is essential in any room as dusty as this.

Amongst workers exposed to concentrations of 100–250 mg/100 m^3, some byssinosis was present even in those with less than 10 years exposure. Thus, dust control is also desirable where the concentration lies in this range.

No worker exposed to a concentration of less than 100 mg/100 m^3 had byssinosis Grade 1 or 2. However, a man with a long experience did complain of occasional chest tightness on Mondays (byssinosis Grade 1/2) so that, although a card room with a concentration of less than 100 mg/100 m^3 would probably be safe, it would be wise to safeguard the susceptible workers by periodic medical examinations.

From these results we suggest the following grading of workrooms in cotton mills:

Grade		*Concn total dust* (mg/100m^3)
A	Safe, with medical supervision	Less than 100
B	Dust control desirable and medical supervision essential	Between 100 and 250
C	Dust control and medical supervision essential	More than 250

We do not think that dust concentrations can be reduced below 100 mg/m^3 in all card rooms with control devices presently available. However, a realistic target for dust suppression in the immediate future would be dust concentrations of less than 250 mg/m^3.

DISCUSSION

There are two sources of error in the method used to estimate permissible levels of dustiness. First, this was a retrospective survey, which presupposes that dust concentrations have not changed substantially during the working life of the men studied. As far as possible, we tried to overcome this error by choosing mills in which conditions had been stable for 25 years. A prospective survey, in which the environment is measured for several years, would take account of changes in dust concentrations. However, as byssinosis usually takes some years to develop, such a survey could not give quick results. The second source of error is that the mill populations studied are a selected group in the sense that many of those who are susceptible to the dust will have left, and the observed prevalences are likely to be considerably less than the prevalences that would have occurred if no one had left because of the ill-effects of the dust. We can see the effects of such a process of selection in the relationship between prevalence of disease and accummulated dust exposure for different age groups.

It is clear from *Table 4* that the risk of getting byssinosis depends both upon concentration of dust and the number of years at risk. This may be

expressed in one figure as mg· years/100 m³, the product of dust concentration and years of exposure[1]. A dose response curve may be plotted by grouping together workers with similar accumulated dust exposures. For similar exposures there is a lower prevalence of disease among the older workers (*Figure 3*). We could have derived safe levels of dustiness from the dose response curve of the younger workers, but this assumes that the risk of byssinosis is similar for the same accumulated exposures whatever the concentration may be. *Table 5* shows that this is not so. For the same exposures there is less disease with lower concentrations of dust.

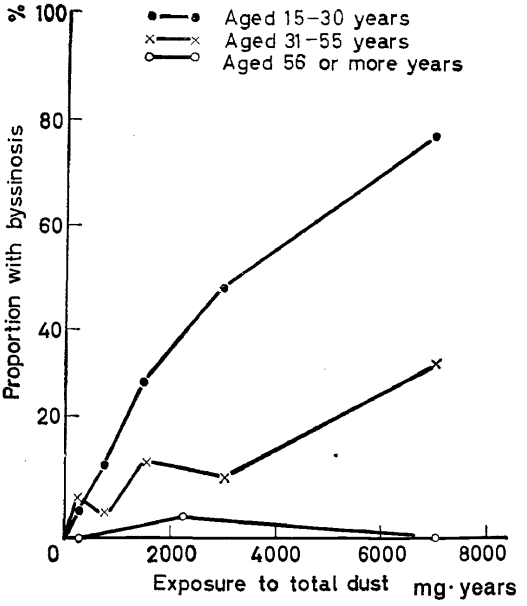

Figure 3. Dust exposure and response—total dust

Table 5. The relationship between prevalence of disease and dust concentration for similar accumulated exposures in workers aged 15–55 years

Concentration (mg/100m³)		*Accumulated dust exposure* (mg· years)		
		0–	1000	4000+
0–299	No. with byssinosis / No. in group	2/126	16/129	12/53
	Prevalence	2%	12%	23%
300+	No. with byssinosis / No. in group	10/22	17/29	22/33
	Prevalence	45%	59%	67%

In this survey there was not a close correlation between the prevalence of byssinosis symptoms and the concentrations of very fine dust. However, it would be unwise to assume that dust particles less than 7μ are altogether unimportant in byssinosis. They may cause effects other than chest tightness.

Because of the many variables which enter into the calculation of safe levels of dustiness, they must be regarded only as a rough guide to safe conditions. Even where low concentrations of dust are achieved, the workers so exposed should be kept under medical surveillance in order to detect those who may be especially susceptible. Biologically, one cannot accept that there is no risk unless there is no dust.

The safe levels which have been proposed are based on concentrations of all the dust, of which the active agent is only a small fraction. The size of this fraction may vary according to the type of cotton being spun. In addition, devices installed to control the dust may also result in changes in the composition of the airborne dust. Such devices may remove proportionately less of the active agent than the inert material. At present, until the toxicity of a cotton dust can be assessed pharmacologically or chemically, the final test of the efficiency of preventive measures must be whether or not byssinosis occurs among workers in rooms where they are installed.

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