Respiratory disability in ex-cotton workers

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ABSTRACT A high proportion of textile workers handling cotton and flax complain of respiratory symptoms and show a loss in lung function. These effects are reversible in the early stages but the degree to which they lead to permanent respiratory disability is unknown. Two surveys were therefore conducted in which respiratory function and symptoms were compared in ex-textile workers and in control subjects who had never been exposed to textile dusts. One survey was of ex-flax workers in Northern Ireland. The present survey was of ex-cotton workers in Lancashire. A survey of random population samples in Oldham and Bolton, in both of which cotton had formerly been the most important source of employment, was conducted. After allowing for age, height, and smoking, lung function was about 2-8% lower in the ex-textile workers than in controls who had never been exposed to any dust. Ex-textile workers were slightly shorter than the controls, suggestive of past social and nutritional deprivation which may have contributed to the decrement in lung function. There was evidence of a small but increasing decrement in lung function with an increase in a "dust exposure" score. For men, about 15 years of heavy dust exposure was associated with a loss in FEV₁ equivalent to that shown by light or ex-smokers. For women, 15 years of heavy dust exposure appeared to be associated with a decrement in FEV₁ about half that of light smoking.

Respiratory symptoms, and in particular the syndrome of byssinosis, are generally agreed to represent an acute and reversible response by the respiratory system to certain textile dusts. Such an effect on exposed workers is important and may be decisive to their continued employment. The question of permanent respiratory disability is quite a different issue, however, and if this does occur it is far more important than any acute, reversible effect.

The evaluation of long term effects is difficult, and clinical impressions may be misleading because of the high prevalence of respiratory symptoms and respiratory disability in the community. Thus in the United Kingdom the prevalence of asthma in the population is around 5-6%^{1,2} and the prevalence of chronic bronchitis is not only high but shows an increase with age.³

Respiratory symptoms and lung function are powerful predictors of death.⁴⁻⁷ A review of relevant evidence by Peto *et al*⁸ showed that in subjects aged 55 to 64, none of whom had had exposure to any industrial dust, a reduction in FEV₁ equivalent to two standard deviations or greater was associated with a fourfold

increase in total mortality during the subsequent 10 years and a 40-fold increase in deaths from respiratory disease. The percentage survival of subjects who had had no dyspnoea when first seen, over a 20 year period, was about 40% in men and 52% in women, whereas those with mild dyspnoea had survival rates of about 22% and 40% and of those with more severe dyspnoea only 16% and 28% survived 20 years. Because of these effects it would be reasonable to expect that mortality would provide a most sensitive test as to whether or not there is permanent respiratory impairment.

Several studies of mortality in textile workers have been conducted. These have failed to give clear evidence of an increased mortality in subjects exposed to textile dusts^{9,10} (SM Daum, *et al*, paper given at XVI international congress on occupational health, Brighton, 1975) or with byssinosis.¹⁰ This last study gave no evidence of an association between dust concentrations and mortality. The evidence on byssinosis in this study was less consistent, largely because of the smaller numbers concerned, but there was certainly no clear evidence of the pronounced increase in mortality that is shown by chronic respiratory symptoms and permanent respiratory impairment in other situations.

The relevance of mortality data to the health of

ex-textile workers has been disputed¹¹ and, therefore, there is a need for evidence on morbidity. Nevertheless, several aspects of any study are most important. Firstly, if it is intended to measure permanent disability then only ex-workers must be examined otherwise acute and reversible effects will be confounded with permanent effects. Secondly, the ex-textile workers seen must be representative of all such subjects; results derived from volunteers are of little value. Thirdly, to avoid bias from the over-reporting of symptoms that are widely known to be relevant to compensation claims by workers, it is essential that data are collected without the objectives of the surveys being known to the participants. Without assurance on these aspects a study will have little credibility.

The survey described in this report was one of two. The other¹² was an identical inquiry based on random samples of subjects in ten towns in Northern Ireland, in all of which flax processing had been a major source of employment.

Method

Two towns in Lancashire (Oldham and Bolton) were selected. In these the processing of cotton had been the major industry, employing almost half the adult workforce, whereas now only about 3% of adults are so employed. Random samples were drawn from the electoral rolls, written to, and then visited. Those aged between 40 and 74 were asked to attend a special clinic. At the clinic height was measured, the MRC questionnaire on respiratory symptoms¹³ asked, forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC) measured with a McDermott spirometer, and an occupational history taken.

Every attempt was made to collect data free from bias. Thus no mention was made at any stage of the main purpose of the survey, the work was referred to as a "health inquiry," and no mention was made to any subject of textiles, cotton, dust, or byssinosis. Furthermore, the occupational history of each subject was the last piece of information to be obtained, after lung function results and symptoms had been recorded.

In the analysis that follows the means of the two highest recordings of FEV₁ and FVC for each subject were used provided that these did not differ by 0.3 l or more; if they did then the highest was used. Analyses were by multiple regression considering FEV₁ and FVC as dependent on age, smoking, and dust exposure. The lung function measurements were standardised, following the method suggested by Cole,¹⁴ to the square of the overall mean height within each sex—namely, FEV₁ (or FVC) $\times (1.7/\text{ht})^2$ for men and $(1.58/\text{ht})^2$ for women.

Smoking in men is classified as light (1–14 cigarettes a day), medium (15–24), and heavy (25 or more a day) and in women at two levels (1–14 and 15 or more a day). Ex-smokers are those who had been smokers and had stopped at least three months before. Pipe and cigar smokers were coded separately.

To prevent any confounding of acute, reversible effects with permanent effects, all subjects found to be currently working in the cotton industry were excluded. Other subjects were grouped according to past occupational dust exposure as follows:

(1) *No dust*—Subjects who had never had a job where there had been exposure to dust or fumes except farming and dusts with no known risk such as building construction or road making.

(2) *Other dust*—Subjects who had had exposure to coal, asbestos, silica, flour, kaolin, talc, bleach, acid, solvents, pesticides, hairdressing, welding, foundry work, mining, tunnelling, but *not* cotton.

(3) *Pure cotton*—Subjects who had been employed in cotton winding, warping, weaving, spinning, carding, stripping and grinding, etc, but none under (2) above.

(4) *Cotton and other*—Subjects who had had exposure to cotton plus one or more of the exposures listed under (2).

Ex-cotton workers were subdivided according to the jobs that they had performed within the industry. A "worst ever" grouping system was used—that is, subjects who had worked for at least one year at carding or any task related to the early processing stages, including stripping and grinding, were coded as "carding." Subjects who had worked for at least one year at spinning or winding or any task related to these, but who had never worked at carding etc were coded as "spinning." Subjects who had worked for at least one year at weaving or any related task were coded as "weaving," unless they had worked for at least one year in either of the above.

The ex-cotton workers were also each given a dust exposure "score." This was the sum of the products of the years within each job in the industry multiplied by a dust score for each job. The dust scores used were derived from a previous study of dust concentrations in mills in the two towns surveyed¹⁵ and discussions with representatives in the industry. These dust scores are displayed in table 1.

Table 1 Dust scores used in calculation of exposure scores for each ex-cotton worker (based on data in Fox *et al*¹⁵)

Job	Bolton	Oldham
Cardrooms	1.0	2.0
Spinning	0.5	1.0
Winding	0.5	2.0
Weaving	0.0	0.5

Results

The number of subjects aged 40–74 in the samples seen in the two towns, after exclusion of 23 workers currently exposed to cotton dust, was 890. This represents 87% of those eligible. Ten subjects were too ill to be seen, 17 were on holiday at the time of the survey, and 107 refused to cooperate. Table 2 shows the distribution of those seen by age and by dust exposure group defined as above. Because few women had worked in other dusty jobs, the groups have been combined in subsequent tables to give just two female groups—"no cotton dust" and "ex-cotton dust."

Table 3 displays the mean lengths of time the subjects, classified by their worst ever exposure, had spent in occupations involving exposure to dust. Clearly, exposures had been substantial and there is relatively little movement between the occupations. Thus the 22 male carders had spent on average 14 years and the 94 female carders 15 years in the card room. The 34 men in the mixed dust exposure group

had spent twice as long in other dusty jobs (mean 17 years) as in cotton jobs (mean 9 years). It would therefore be unwise to attribute any effect on lung function to their exposure to cotton. On the other hand, only eight women were in the mixed exposure group and these had spent 20 years on average in cotton jobs and only five years in other dusty jobs. It seemed reasonable therefore to combine these groups in the women and to attribute all effects to their exposure to cotton dust.

Table 4 shows the mean heights of subjects in the study. Overall, the ex-cotton workers were shorter than the subjects who had not been exposed to any dust. After allowing for age the difference from those never exposed to dust was 1.9 cm in male and 1.1 cm in female ex-cotton workers. Although the direct effect of height on lung function is allowed for statistically in the analyses that follow, the differences between the subgroups should be noted, as they suggest previous selection into the cotton industry.

Table 2 Sample in the survey subdivided by age and by past exposure to dust

	Age (years)			
	40–54	55–64	65–74	All ages
Men:				
No dust	105	72	45	222
Ex-cotton	28	32	45	105
Other dusts	35	32	12	79
Ex-cotton + other dust	12	13	9	34
Women:*				
No dust	107	55	34	196
Ex-cotton	72	77	84	233
Other dusts	4	7	2	13
Ex-cotton + other dust	2	3	3	8
Totals	365	291	234	890†

*In subsequent tables the women are amalgamated into two groups: those exposed to cotton dust (with or without exposure to other dusts) and those not exposed to cotton (with or without other dust exposure).

†After exclusion of current workers 890 subjects remained. For four subjects smoking habit was not recorded so 886 subjects are the base for all subsequent tables.

Table 3 Mean length of time (years) spent in dusty occupations by subgroups of subjects classified by dust exposure group in terms of their worst ever exposure

Dust exposure group	No of subjects	Mean years of exposure to			
		Other dust	Weaving	Spinning winding	Carding
Men:					
No dust	220	0	0	0	0
Ex-cotton weavers	36	0	15	0	0
Ex-cotton spinners	46	0	1	16	0
Ex-cotton carders	22	0	1	2	14
Other dusts	78	20	0	0	0
Ex-cotton + other dust	34	17	2	4	3
Women:					
No cotton dust	203	1	0	0	0
Ex-cotton weavers	33	0	13	0	0
Ex-cotton spinners	107	0	1	17	0
Ex-cotton carders	94	0	0	3	15

Table 4 Mean heights (m) of subgroups of subjects

Subgroup	Age group (years)					
	40-54		55-64		65-74	
	No	Mean height	No	Mean height	No	Mean height
Men:						
No dust	104	1.72	72	1.70	44	1.67
Ex-cotton workers	28	1.68	32	1.68	44	1.67
Other dusts	34	1.72	32	1.70	12	1.70
Ex-cotton + other dusts	12	1.75	13	1.69	9	1.62
Women:						
No cotton dust	109	1.60	59	1.58	35	1.57
Ex-cotton workers	73	1.59	79	1.58	82	1.55

SD of height is about 0.7 m.
For 13 subjects, height was not recorded.

Tables 5 and 6 display the coefficients from regression analyses of the lung function data. Losses with age are about 50 ml for both FEV₁ and FVC in men and 32 and 36 ml in women per year of age for FEV₁ and FVC respectively. Losses attributable to smoking are larger in men and range up to about 400 cc of FEV₁ and 300 cc FVC, compared with up to about 300 cc FEV₁ and 200 cc FVC in women. Losses attributable to previous exposure to dust are somewhat smaller than those due to smoking. Independent of any effects of age and smoking, men who had been in weaving gave no evidence of any loss whereas women who had been so employed had lower lung function by about 170 cc FEV₁ and much the same in FVC. The losses in subjects who had worked in carding were about 150-180 cc FEV₁ and FVC compared with subjects who had never been exposed to dust, though the men who had worked in carding etc had a mean FVC that was 370 cc lower. On the other

hand, the women who had worked in jobs such as spinning showed virtually no loss in lung function. There was no evidence in these data of the interaction between age and dust exposure which was found in the survey of ex-flax workers in Northern Ireland¹² that had been conducted at the same time.

For FEV in men, the addition of occupation as a factor at six levels does not add significantly to a model that already includes age and smoking, and none of the three cotton groups differs significantly from the no dust group. There is some suggestion, however, of a trend of increasing loss of lung function in the groups with the worst exposure to cotton. For FEV₁ in women, the addition of occupation as a factor at four levels does add significantly ($F(3,429) = 2.66, p < 0.05$) to the model with age and smoking alone and the carders have a significantly ($p < 0.05$) lower FEV₁ than the group of subjects never exposed to cotton. In the women exposed to cotton, however, the pattern is inconsistent as the spinners and winders have the highest FEV₁ whereas the lightly exposed

Table 5 Regression coefficients for FEV₁ (l) in subjects aged 40-74 in two cotton towns in Lancashire

	Men	Women
Constant	5.92	3.94
Age (years)	-0.052	-0.032
Current smoking:		
Non-smoker	0.00	0.00
Ex-smoker	-0.18	-0.13
Cigar or pipe	-0.34	—
Light smoker	-0.21	-0.16
Medium smoker	-0.43	-0.29†
Heavy smoker	-0.39	
Previous dust exposure:		
No dust*	0.00	0.00
Weaving	+0.02	-0.17
Spinning	-0.18	-0.04
Carding	-0.18	-0.15
Other dusts	-0.20	—
Cotton + other dusts	-0.25	—

*The few women who had had exposures to dusts other than cotton (see table 2) included here.

†Medium and heavy smoking combined in women in this and in subsequent tables.

Lung function was not recorded for 13 subjects.

For differences between occupation groups, after allowing for age and smoking habit: Men $F(5 \text{ and } 424 \text{ df}) = 1.82$ NS Women $F(3 \text{ and } 429 \text{ df}) = 2.66$ $p < 0.05$.

Table 6 Regression coefficients for FVC (l) in subjects aged 40-74 in two cotton towns in Lancashire

	Men	Women
Constant	6.90	4.86
Age (years)	-0.049	-0.036
Current smoking:		
Non-smoker	0.00	0.00
Ex-smoker	-0.15	-0.08
Cigar or pipe	-0.21	—
Light smoker	-0.11	-0.03
Medium smoker	-0.21	-0.19
Heavy smoker	-0.29	
Previous dust exposure:		
No dust	0.00	0.00
Weaving	-0.02	-0.16
Spinning	-0.23	-0.05
Carding	-0.37	-0.18
Other dusts	-0.16	—
Cotton + other dusts	-0.17	—

*Lung function was not recorded for 13 subjects.

For differences between occupation groups, after allowing for age and smoking habit: Men $F(5 \text{ and } 424 \text{ df}) = 1.84$ NS Women $F(3 \text{ and } 429 \text{ df}) = 2.78$ $p < 0.05$.

weavers have a loss of FEV_1 that is slightly higher even than that of the carders. The findings for FVC are similar to those for FEV_1 and, again, although in men the addition of occupation does not add significantly to the model, yet within the groups exposed to cotton there is a trend of higher losses with higher exposure so that the carders have significantly ($p < 0.05$) lower FVC than the no dust group. For FVC in women the addition of occupation is again statistically significant and the carders have significantly lower FVC than women in the no cotton dust group. But again there is the inconsistency that the lightly exposed weavers have an FVC similar to the carders whereas the more heavily exposed spinners and winders are similar to those in the no cotton dust group.

Perhaps the simplest way to summarise the results is to use the regression equations to predict lung function in the different occupation groups for a fixed age, height, and smoking habit. This is done in table 7 for FEV_1 and table 8 for FVC. Predicted values by occupation are calculated for 55 year old non-smokers of average height. For comparison the tables also include predicted lung function in the different smoking groups, again for 55 year old subjects of average height and with no dust exposure. Lung function is worst in those who had worked in carding—namely, a decrease of about 6–9% in FEV_1 and FVC. Ex-weavers show an inconsistent effect, results being lower only in women. It seems that the mean FEV_1 of subjects who had worked in cotton is lower than that of subjects who had never been exposed to any dust by about the same amount as the effect of light smoking. The loss in FVC in ex-cotton workers is equivalent to the effect of moderate to heavy smoking.

The data based on the classification of the ex-cotton workers by dust exposure score are difficult to summarise. Regression analyses of FEV_1 and FVC on age, smoking group, town, and dust exposure score yielded the regression coefficients for exposure score shown in table 9. The coefficients imply that FEV_1 is lower by 8 ml and FVC by 11 ml in men for every increase of one in the dust exposure score. Thus a man who had worked for, say, 15 years in the most dusty situation we envisaged—namely, a cardroom in Oldham—would probably have an FEV_1 about 240 ml and an FVC about 330 ml lower than a man of the same age never exposed to dust. For women, however, the differences in this most highly exposed subgroup compared with women never exposed are probably much smaller, about 60 ml for FEV_1 and about 90 ml for FVC.

The data for symptoms showed that chronic bronchitis had a higher prevalence in men than in women, but in neither sex was there a significant age effect. Symptoms were about four times more prevalent in

male cigarette smokers than in male non-smokers, whereas the difference in women was about threefold (for both $p < 0.001$). Table 10 shows the effect of occupational group on prevalence of chronic bronchitis. The smoking habits of the various occupational groups are similar but the cotton workers are, on average, about four years older than the other occupational groups. Among men the effect of occupation is not statistically significant after allowing for age and smoking habit. Among women the prevalence of chronic bronchitis is slightly higher in the ex-cotton group than in the no cotton group, but again this is not statistically significant.

Table 7 Predicted FEV_1 in subjects of average height, aged 55, and % differences from levels in non-smoking subjects never exposed to dust. Values shown for ex-cotton workers are independent of smoking: values shown for smoking are independent of dust exposure

	Men		Women	
	FEV_1 (l)	(%)	FEV_1 (l)	(%)
No dust	3.06		2.18	
Ex-cotton weavers	3.08	(+1%)	2.01	(-8%)
Ex-cotton spinners	2.88	(-6%)	2.14	(-2%)
Ex-cotton carders	2.88	(-6%)	2.03	(-7%)
Other dusts	2.86	(-7%)	—	
Cotton + other dusts	2.81	(-8%)	—	
Non-smokers	3.06		2.18	
Smokers 1-14/day	2.85	(-7%)	2.02	(-7%)
Smokers 15-24/day	2.63	(-14%)	1.89	(-13%)
Smokers ≥ 25 /day	2.67	(-13%)		

Table 8 Predicted FVC in subjects of average height, aged 55 and % differences from levels in non-smoking subjects never exposed to dust. Values shown for ex-cotton workers are independent of smoking: values shown for smoking are independent of dust exposure

	Men		Women	
	FVC (l)	(%)	FVC (l)	(%)
No dust	4.21		2.88	
Ex-cotton weavers	4.19	(0%)	2.72	(-6%)
Ex-cotton spinners	3.98	(-5%)	2.83	(-2%)
Ex-cotton carders	3.84	(-9%)	2.70	(-6%)
Other dusts	4.05	(-4%)	—	
Cotton + other dusts	4.04	(-4%)	—	
Non-smokers	4.21		2.88	
Smokers 1-14/day	4.10	(-3%)	2.85	(-1%)
Smokers 15-24/day	4.00	(-5%)	2.69	(-7%)
Smokers ≥ 25 /day	3.92	(-7%)		

Table 9 Regression coefficients (SE) for a dust exposure score derived from regression of FEV_1 and FVC (l) on age, smoking habit, and town and dust exposure

Regression coefficients			
FEV_1	Men	0.008**	(0.003)
	Women	0.002	(0.0014)
FVC	Men	0.011***	(0.003)
	Women	0.003*	(0.0015)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 10 Prevalence of symptoms in subjects subdivided by occupational group

	Chronic bronchitis*		Dyspnoea†	
	No of subjects	No (%) with symptoms	No of subjects	No (%) with symptoms
Men:				
No dust	215	41 (19%)	214	66 (31%)
Ex-cotton workers	105	22 (21%)	102	51 (50%)
Other dusts	78	24 (31%)	74	30 (41%)
Ex-cotton + other dusts	34	10 (29%)	33	18 (55%)
Women:				
No cotton dust	207	27 (13%)	200	89 (45%)
Ex-cotton workers	234	45 (19%)	227	137 (60%)

*For 13 subjects symptoms relevant to chronic bronchitis were not recorded.

†For 36 subjects symptoms relevant to dyspnoea were not recorded, mostly because they were disabled.

The prevalence of dyspnoea (MRC grades 1, 2, and 3 combined) was higher in women and in both sexes showed a significant rise with age: from 26% and 46% in men and women aged 40–54 to 63% and 64% at ages 65–74. The weak association between smoking and dyspnoea was significant (at $p < 0.05$) only in women. Table 10 shows that the prevalence of this symptom is higher among men who have ever worked in a dusty occupation than among those who have never worked in a dusty occupation ($p < 0.05$), but there is no evidence that the prevalence of dyspnoea varies according to whether the dust is cotton or otherwise. In women the prevalence of dyspnoea is significantly ($p < 0.05$) higher among those who have ever worked in cotton.

Discussion

The view that permanent effects can follow exposure to textile dusts is surprising as almost no relevant evidence exists. Virtually all the epidemiological work on respiratory disease in textile workers has been done within cotton and flax mills. To draw conclusions from such inquiries as to whether or not a reversible condition that occurs at work leads to permanent effects is clearly invalid. Undoubtedly permanent respiratory disability does occur in any group of workers, be they in the textile or any other industry, but the extent to which the disability observed in selected textile workers is simply asthma or chronic bronchitis, unrelated to exposure to textile dust, is unknown and can only be ascertained from epidemiological inquiries such as those we now present.

In fact, there are several reasons why one would not expect irreversible effects. The only feature that is characteristic of byssinosis is the periodicity of the symptoms within the working week; there are no clinical signs peculiar to byssinosis. No biochemical, radiological, or pathological changes have been shown to occur in byssinosis, and there is no evidence of any decrease in survival^{9 10} (SM Daum *et al*, Brighton 1975). All this contrasts with the massive

changes in the lungs of workers with pneumoconiosis that may be detected before or after death. Indeed in the pneumoconioses distinctive radiological, macroscopic, and microscopic changes occur even before disability can be detected clinically and before there is any increased risk of death.^{16–18}

Only one other study of ex-textile workers has so far been reported^{19–21} but this has several serious uncertainties. Briefly, the exposed workers and the controls came from two distinct geographical areas: the response rate of a defined group of card or weave room workers was only 40% and these were supplemented by self selected workers, recruited by “word of mouth” from a group of unknown size. A further major uncertainty arises from the fact that the reports give no evidence that any attempt was made to conduct the inquiry “blind” and therefore the extent of bias from over-reporting of symptoms by the textile and ex-textile workers is unknown. In a review of this and other evidence relating cotton dust exposure to chronic lung disease Diem commented “... the evidence... is not conclusive. There is no consistency across population-based studies, and adequate dose-response relationships have not yet been found. Thus, two important criteria for inferring causality from observational studies... are not satisfied by the available data.”²²

The present study gives evidence suggestive of a small permanent effect of past exposure to cotton dust on respiratory function. The existence of a significant increase in the effect with increasing past dust exposure suggests that the effect is real, but it is small, and the data suggest that even after prolonged exposure to the most dusty conditions the loss is likely to be, at most, comparable with that associated with light smoking.

The inquiry we describe in the present report was conducted simultaneously with an identical but much larger survey in Northern Ireland¹² where flax processing is a major source of employment. Both surveys were based on random samples of ex-textile workers and random samples of subjects from the

background population in the same areas, and high response rates were maintained throughout. The results of the two inquiries are remarkably similar, the differences in lung function between ex-textile workers and subjects never exposed to dust being about 5%, or comparable with the effects of light smoking. In the study of ex-flax workers there was evidence of a significant negative interaction between past exposure to dust and age. The oldest ex-workers—that is, those who had had the longest exposures and who presumably had been exposed to the highest concentrations of dust—differed little from the subjects not exposed to dust, and it was only the youngest ex-flax workers who showed a significant decrement in lung function.¹² No such interaction was detected in the present study. On the other hand, whereas in the present survey of ex-cotton workers a significant positive effect was detected between lung function and a dust exposure score, a negative effect of this type was detected in the ex-flax workers—that is, the ex-flax workers who had the highest dust exposure scores showed a smaller difference in lung function than those who had low scores.

These inconsistencies between two surveys of ex-textile workers, conducted with similar protocols, are surprising but could result from different selection processes of subjects who entered the two industries at different times. Further evidence suggestive of selection into the industry comes from the data on height (table 4). The overall mean difference of about 2 cm in male and 1 cm in female ex-cotton workers and the subjects never exposed to dust compare with mean differences in a recent national survey in Great Britain between the upper and the lower social classes (classes I and II and IV and V in the Registrar General's classification) of just over 3 cm in adults aged 45–64.²³ Height is a good index of past social and nutritional conditions^{24 25} and there is a strong relation between respiratory disease and social factors.^{26 27} The effects of this selection on the results for the ex-textile workers that we present cannot be adequately evaluated, but they suggest that not all of the differences we detect in respiratory health between ex-textile workers and other members of the random samples are due alone to past exposure to dust.

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