

Byssinosis among Winders in the Cotton Industry

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In a mill spinning coarse cotton the prevalence of byssinosis and other respiratory symptoms, and the F.E.V.₁₋₀, were measured in a group of 29 men and 117 women employed in the winding room. All the men and 95% of the women at risk were included.

Dust concentrations, measured with a modified Hexhlet at various work points in the winding room, ranged from 1.65 to 6.05 mg./m.³ total dust. These concentrations are higher than 1.0 mg./m.³, which is the threshold limit value for cotton dust recommended by the American Conference of Governmental Industrial Hygienists. The mean dust concentration was 3.48 mg./m.³ compared with 2.85 mg./m.³ in the card room of the same mill.

The prevalence of byssinosis was 18.8% among the women and 13.8% among the men. A comparison among the women showed that those with symptoms of byssinosis had, on the average, significantly lower F.E.V.s than women of similar age without such symptoms. Four women and one man with moderately severe symptoms of byssinosis showed evidence of permanent respiratory disability with effort intolerance and a substantial diminution in F.E.V.₁₋₀. Further studies should be carried out in other winding rooms because, if these findings are repeated elsewhere, they would indicate the necessity for medical surveillance, dust control, and extending the compensation scheme to include winding room workers.

In Great Britain, the compensation scheme for byssinosis among cotton workers is restricted to persons employed in opening, blow, and card rooms. The occupations included in the scheme were last reviewed by the Industrial Injuries Advisory Council in 1960. It reported that there was insufficient evidence to warrant the inclusion of spinners working in mule or ring rooms, since field surveys, and clinical investigation of selected patients, had revealed that disabling byssinosis was rarely found among mule spinners and presented no problem among ring spinners (Ministry of Pensions and National Insurance, 1960). There is further evidence from other countries that byssinosis occurs only in a milder form among spinners and weavers (Schilling, Vigliani, Lammers, Valić, and Gilson, 1964), but no surveys of byssinosis among winders have been reported.

In a recent study of female workers employed in the card, blow, and ring rooms of a mill spinning coarse cotton, the survey was extended at the request of the mill manager to include both male and female winders. He had noted that the increasing speeds of processing cotton yarns appeared to have given

rise to higher dust levels in the winding rooms.

The survey of workers and the measurements of airborne dust in the winding room were undertaken during the summer and late autumn of 1965.

Description of Process

In the winding room, the spun cotton yarn from the ring room is prepared for weaving. For the weft, ring room bobbins may be used without further processing or, if they are unsuitable for the shuttles, they are rewound into spools of the right size.

To prepare the warp yarns, bobbins from the ring room are first wound into much larger units, called cones or cheeses. This may be done either on Abbott winding machines (Fig. 1), which are rapid and semi-automatic, or on older and slower machines (Fig. 2). The cones and cheeses are then mounted in a bank of creels from which all the threads are led in parallel lines to the beam (Fig. 3). It is the yarn wound on a beam that ultimately forms the warp. This is wound either on high-speed beaming machines or on the slow-speed 'Lancashire' beaming machines. The women workers fall into three main groups: Abbott winders; cone, cheese, and bobbin winders; and high-speed beamers. There are



FIG. 1. Abbott winding.

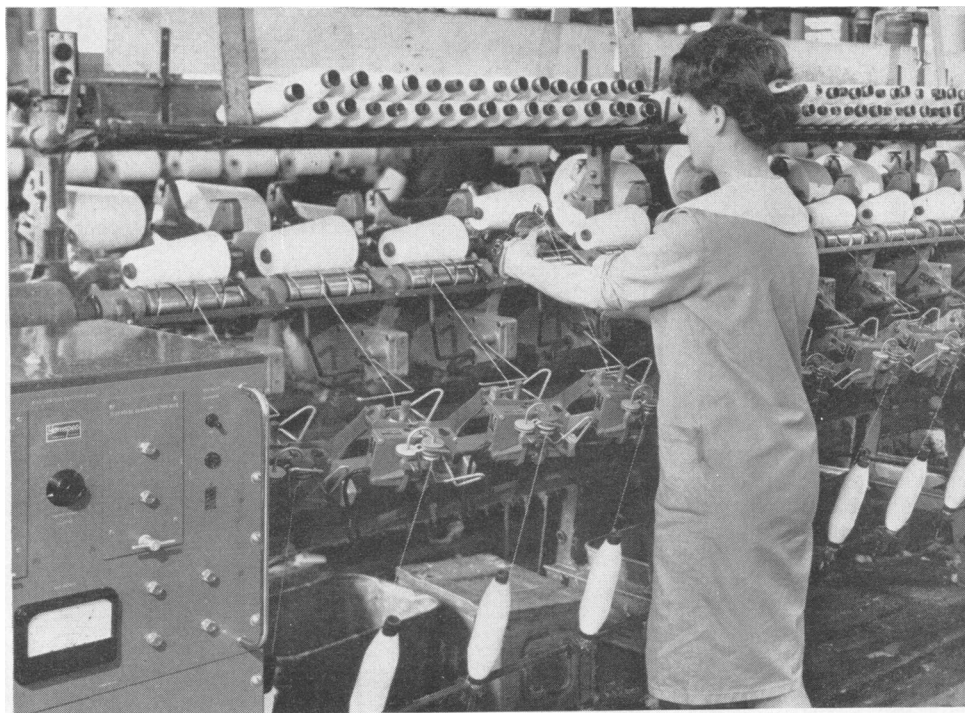


FIG. 2. Cone winding.

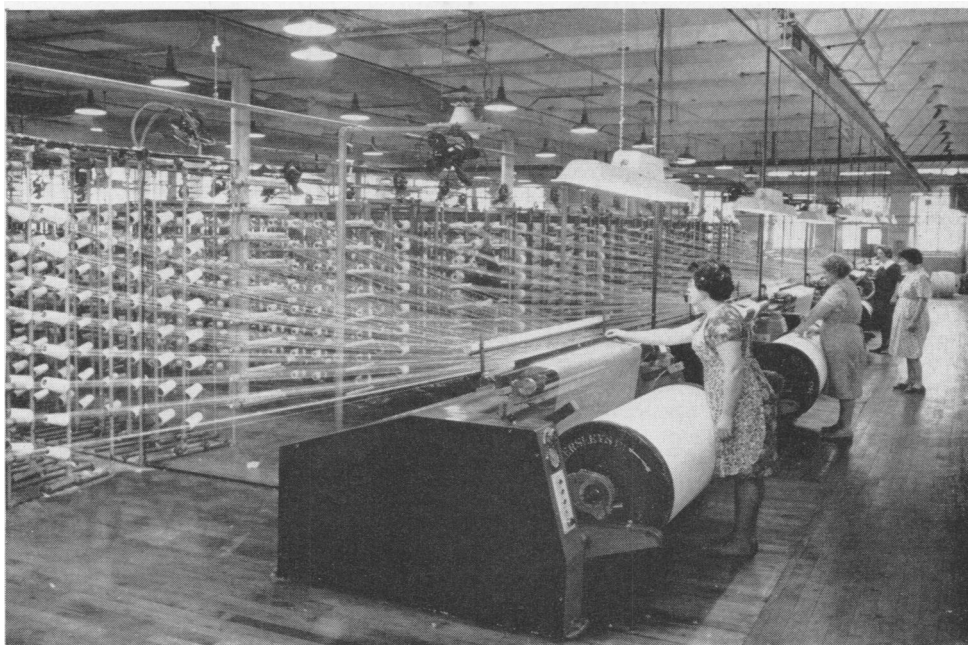


FIG. 3. Automatic high-speed beaming.

smaller groups employed as Lancashire beamers, sweepers, and cutters. The latter cut off the waste thread left on the spools. The women usually continue on the same job once they have acquired the necessary skill. Men are employed as overlookers and weft, beam, and bobbin carriers, and are continually walking in and out of the winding room.

Population There were 123 women and 29 men on the works list of winding room employees at the beginning of the survey. All the men and 117 (95.1%) of the women were seen. Three of the women were away sick during the survey and were interviewed at home but their F.E.V.s could not be recorded.

The winders work in two shifts. There is an 'early' shift from 6.00 a.m. to 2.00 p.m., and a 'late' shift from 2.00 p.m. to 10.00 p.m. The working week is from Monday to Friday and the workers change shifts weekly.

Methods

Dust Sampling Airborne dust was sampled during the whole eight-hour shift in the areas in which workers were employed, to obtain a gravimetric measure of dust concentration.

The method of sampling, using a modified Hexhlet apparatus, was the same as that used in previous surveys (Roach and Schilling, 1960). It gives three sized components, coarse, medium, and fine. The coarse fraction

is the dust retained by a 2 mm. mesh gauze at the inlet to one sampler. The medium and fine together is the dust which passes through the gauze. The fine fraction is the dust which passes through a horizontal elutriator on the second sampler. This elutriator excludes all particles more than 7.1μ equivalent diameter. The weight of medium dust is obtained by difference.

Questionnaire Respiratory symptoms, past history of chest disease, smoking habits, and occupational histories were recorded for each worker using the standard M.R.C. questionnaire on respiratory symptoms extended by adding questions on byssinosis (Lammers, Schilling, and Walford, 1964).

Byssinosis was graded as follows:

- | | |
|---|---|
| Grade $\frac{1}{2}$ | occasional chest tightness on Mondays |
| Grade 1 | chest tightness and/or difficulty in breathing on every Monday at work |
| Grade 2 | chest tightness and/or difficulty in breathing on Mondays and other days |
| Effort intolerance was graded as follows: | |
| Grade I | (normal) not troubled by shortness of breath when hurrying on the level or walking up a slight hill |
| Grade II | (slight) troubled by shortness of breath when hurrying on the level or walking up a slight hill |
| Grade III | (moderate) short of breath walking with other people at an ordinary pace on the level |
| Grade IV | (severe) having to stop for breath when walking at own pace on the level |

Grade V (very severe) short of breath on washing or dressing.

This part of the survey was undertaken by two observers.

Ventilatory Function Test The forced expiratory volume over 1.0 second (F.E.V._{1.0}) was measured with a spirometer and timer by one of the observers (S.M.) after the questionnaire had been completed. The general procedure was similar to that used and described in previous investigations, the results being based on the mean of three readings after two practice blows (McKerrow, McDermott, Gilson, and Schilling, 1958).

Exposure to cotton dust is associated with a fall in ventilatory capacity during the work shift (McKerrow *et al.*, 1958). In workers suffering from byssinosis, this fall is particularly marked and provides additional and more objective evidence of the effects of the dust to support that based on the history of chest tightness on Mondays (Batawi, Schilling, Valić, and Walford, 1964).

After completing the survey using the questionnaire and ventilatory function test a study was made of changes in ventilatory capacity on two consecutive Mondays in 24 women and four men. On the first Monday six women and one man with symptoms of byssinosis and the same number, matched as far as possible for occupation, age, and smoking habits, but without such symptoms, were selected from the early shift. A similar group of men and women was selected from the late shift. On the following Monday the same workers were seen again when they had changed shifts. Forced expiratory volumes were measured at the beginning and end of each shift by one of the observers (S.M.).

Results

Dust Concentrations There was a wide range of dust concentrations in the winding room (Table I). At all points at which samples were taken, the average concentration of total dust was above 1 mg./m.³, the threshold limit value recommended by the American Conference of Governmental Industrial Hygienists for cotton dust (Ministry of

Labour, 1965). The concentration of dust was higher near the high-speed beamers (6.05 mg./m.³ total dust) than near the low-speed Lancashire beamers (1.65 mg./m.³ total dust). It was also higher near the Abbott winding machines than near the bobbin, cheese, and cone winding machines. These figures illustrate the effect that higher speeds of production have, particularly on total dust concentrations. That there is less difference around the fast and slow machines for the fine dust concentrations may be explained by the filtering effect of the coarse dust and by the fact that the fine dust falls slowly and is carried by currents of air well beyond its point of origin. The coarse fibres greater than 2 mm. long are too large to penetrate into the bronchi, but the coarse dust which collects on the gauze at the inlet to the sampler does filter out some of the medium and fine dust. For this reason the coarse fraction cannot be entirely ignored. Nevertheless, the concentration of the remainder of the dust is still well above 1 mg./m.³ at four out of the five sampling points. The fine dust produces acute changes in ventilatory capacity which are characteristic of exposure to cotton dust. Its concentration is highest near the Abbott winders (0.65 mg./m.³) and the bobbin, cheese, and cone winders (0.60 mg./m.³).

Symptoms of Byssinosis Among the three main groups of female workers, the highest prevalence of symptoms of byssinosis occurred among the Abbott winders (29.6%) and the lowest among the high-speed beamers (11.6%). The bobbin, cheese, and cone winders had a prevalence of 18.7% (Table II). The mean age of these groups was similar but the average number of years spent in other jobs in the cotton industry was highest among the Abbott winders, all but one of whom had previously been bobbin, cheese, and cone winders; the time spent on Abbott winding itself was short

TABLE I
DUST CONCENTRATIONS IN THE WINDING ROOM AT DIFFERENT SITES OF WORK

| Work Place | Total No. of Samples Taken | Dust Concentrations (mg./m. ³) | | | | | | Total |
|-------------------------------------|----------------------------|--|-----------|--------------------|---------|------------------|----------|-------|
| | | Fine (< 7 μ) | | Medium (7 μ-2 mm.) | | Coarse (> 2 mm.) | | |
| | | Mean | Range | Mean | Range | Mean | Range | |
| Abbott winders | 23 | 0.65 | 0.2-1.2 | 1.72 | 1.2-2.7 | 1.43 | 0.6-3.5 | 3.8 |
| Cone, bobbin, and cheese winders .. | 12 | 0.60 | 0.2-1.2 | 1.15 | 0.1-1.8 | 1.0 | 0.5-2.03 | 2.75 |
| High-speed beamers | 23 | 0.46 | 0.2-0.7 | 2.1 | 0.1-2.7 | 3.49 | 0.05-4.2 | 6.05 |
| Lancashire beamers | 12 | 0.30 | 0.1-0.6 | 0.62 | 0.4-0.9 | 0.73 | 0.05-2.5 | 1.65 |
| Cutters | 6 | 0.58 | 0.08-1.08 | 1.4 | 1.3-1.5 | 1.15 | 1.1-1.2 | 3.13 |

TABLE II
PREVALENCE OF BYSSINOSIS AMONG FEMALE AND MALE WINDING ROOM OPERATIVES

| Job | No. Employed | Age at Onset of Survey (yrs.) | | Average No. of Years in Present Job | Average No. of Years in Cotton Industry (including years in present job) | Grades of Byssinosis (No.) | | | | Total with Byssinosis | | |
|---|--------------|-------------------------------|-----------|-------------------------------------|--|----------------------------|----------|----------|----------|-----------------------|-------------|--|
| | | Range | Average | | | 0 | 1 | 2 | 3 | No. | % | |
| Females | | | | | | | | | | | | |
| Abbott winding .. | 27 | 25-57 | 39 | 6 | 19 | 19 | 1 | 3 | 4 | 8 | 29.6 | |
| Other winding (bobbin, cheese and cone) | 32 | 15-58 | 40 | 15 | 16 | 26 | 4 | 2 | 0 | 6 | 18.7 | |
| High-speed beamer .. | 43 | 17-60 | 39 | 10 | 17 | 38 | 3 | 2 | 0 | 5 | 11.6 | |
| Lancashire beamer (slow-speed) | 4 | 57-63 | 60 | 30 | 42 | 3 | 0 | 0 | 1 | 1 | — | |
| Sweepers | 2 | 61-62 | 62 | 4 | 22 | 0 | 1 | 1 | 0 | 2 | — | |
| Cutters | 9 | 16-57 | 41 | 2 | 3 | 9 | 0 | 0 | 0 | 0 | — | |
| Total | 117 | 15-63 | 40 | 10 | 18 | 95 | 9 | 8 | 5 | 22 | 18.8 | |
| Males | | | | | | | | | | | | |
| Weft, beam, and bobbin carriers | 29 | 16-73 | 42 | 8 | 14 | 25 | 2 | 1 | 1 | 4 | 13.8 | |

because this is a relatively new process in this mill. The prevalence of advanced byssinosis is greatest in this group; four of the five female winders with grade 2 byssinosis were Abbott winders.

Among the other female workers, one of the four Lancashire beamers and both the sweepers had symptoms of byssinosis. The average age and number of years spent in the cotton industry were highest in these occupations. None of the nine cutters was affected. All of them had spent a relatively short time in the cotton industry. Four (13.8%) of the 29 men in the winding room had symptoms of byssinosis; one had grade 2 symptoms.

Eighty-three of the women interviewed and 15 of the men (67.1% of the total population) had not worked in any other process but winding during

their service in the cotton mills, and 13.3% of these had symptoms of byssinosis.

Ventilatory Function

Acute Effects of Dust Exposure (changes in F.E.V. during shifts) The results of comparative tests on 14 workers with and 14 workers without byssinosis are given in Table III. Those with byssinosis began the shift with lower F.E.V.s than those without byssinosis and showed a greater fall in ventilatory capacity during three of the four shifts. On the first Monday, during the late shift there was a large drop in F.E.V. in the group without byssinosis.

A recent study of F.E.V. changes during the shift in Dutch male cotton workers revealed a diurnal variation in ventilatory capacity among men without byssinosis who showed a mean rise in F.E.V. during

TABLE III
MEAN F.E.V._{1.0} AT BEGINNING OF SHIFT AND MEAN CHANGE DURING SHIFT IN 14 WORKERS WITH SYMPTOMS OF BYSSINOSIS AND 14 WORKERS WITHOUT SYMPTOMS

| Group of Workers | Mean Age (years) | Early Shift | | | Late Shift | | |
|--------------------|------------------|-------------|---|------------------|-------------|---|------------------|
| | | Day of Test | Mean Initial F.E.V. _{1.0} (l.) | Mean Change (l.) | Day of Test | Mean Initial F.E.V. _{1.0} (l.) | Mean Change (l.) |
| With byssinosis .. | 47 | 1st Monday | 1.66 | -0.13 | 2nd Monday | 1.62 | -0.26 |
| | 54 | 2nd Monday | 1.62 | -0.24 | 1st Monday | 1.56 | -0.20 |
| Without byssinosis | 43 | 1st Monday | 2.42 | -0.03 | 2nd Monday | 2.34 | -0.06 |
| | 43 | 2nd Monday | 2.03 | -0.08 | 1st Monday | 2.17 | -0.31 |

TABLE IV
COMPARISON OF MEAN F.E.V._{1.0} IN FEMALE WINDING ROOM WORKERS WITH AND WITHOUT SYMPTOMS OF BYSSINOSIS

| Age Group | With Symptoms of Byssinosis | | | Without Symptoms of Byssinosis | | | | |
|------------------------|-----------------------------|---|-----------------------------|--------------------------------|-----|---|-----------------------------|-------------------------------|
| | No. | Mean F.E.V. Adjusted for Height ¹ (l.) | Mean F.E.V. Unadjusted (l.) | Mean Age Within Group (years) | No. | Mean F.E.V. Adjusted for Height ¹ (l.) | Mean F.E.V. Unadjusted (l.) | Mean Age Within Group (years) |
| 15- | — | — | — | — | 13 | 2.82 | 2.87 | 20 |
| 25- | 3 | 2.22 | 2.30 | 31 | 25 | 2.58 | 2.63 | 30 |
| 35- | 5 | 2.01 | 1.99 | 41 | 26 | 2.30 | 2.30 | 39 |
| 45- | 6 | 1.87 | 1.87 | 51 | 19 | 2.08 | 2.11 | 50 |
| 55+ | 8 | 1.34 | 1.26 | 58 | 9 | 1.78 | 1.68 | 58 |
| All ages over 25 years | 22 | 1.76 | 1.73 | 48.5 | 79 | 2.28 | 2.29 | 41 |

¹These F.E.V.s have been adjusted to a height of 156 cm. by the partial regression of F.E.V._{1.0} on standing height $b = 0.025$ litre per centimetre (Ferris *et al.*, 1965).

the early shift and a fall during the late and night shifts. Men with byssinosis had a smaller fall in F.E.V. on the early than on the late and night shifts (Walford, Lammers, Schilling, van den Hoven, van Genderen, and van der Veen, 1966). In the present study all groups, including those without byssinosis, showed a reduction in ventilatory capacity during both early and late shifts, although it was rather more marked during the late shift. Since the winding room workers were exposed to much higher concentrations of dust than the Dutch card room workers it is not surprising that the general tendency was for the F.E.V. to fall during both shifts.

Long-term Effects of Dust Exposure (F.E.V.s of women workers with and without byssinosis) The results of the F.E.V._{1.0} tests taken at the time of the interview during the work shift are given for the female workers in Table IV and Figure 4. Since there was some variation in mean height the mean F.E.V. adjusted for standing height is shown for each age group. The height was adjusted to 156 cm. by the partial regression of F.E.V._{1.0} on standing height, $b = 0.025$ litre per cm., given by Ferris, Anderson, and Zickmantel (1965). Women with byssinosis symptoms have, on the average, lower F.E.V.s than those without symptoms. An overall comparison of F.E.V._{1.0} was made only in women over 25 years of age. At these ages the women without symptoms of byssinosis were on the average taller than those with symptoms by 1.4 cm., but since this would make a difference of only 0.04 l. in F.E.V._{1.0}, the unadjusted values were used for comparison. The mean difference in F.E.V. was calculated separately for each age group and weighted

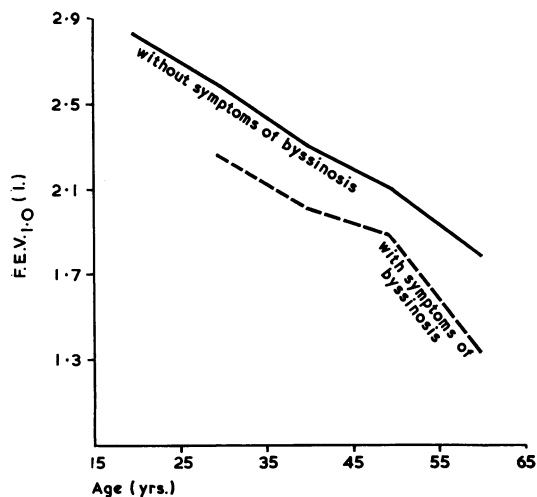


FIG. 4. Mean F.E.V._{1.0} adjusted to standing height in female workers with and without symptoms of byssinosis.

to allow for variation in the size of the groups. The mean weighted difference was 0.32 l.¹ and was statistically significant at the 0.01 level of confidence. Since the F.E.V.s were measured during the work shift, this difference could be accounted for partly by the greater susceptibility to cotton dust of those persons with byssinosis.

¹The weight applied to the mean difference for each age group is given by $w = (n_1 \times n_2)/(n_1 + n_2)$ where n_1 is the number of byssinotics in that age group and n_2 is the number of non-byssinotics.

TABLE V
OCCUPATIONAL AND CLINICAL HISTORIES OF WORKERS WITH GRADE 2 BYSSINOSIS IN THE WINDING ROOM
(for details see Appendix, p. 131)

| Patient No. | Sex | Age | Occupation | Years in Cotton | | Recent History of Bronchitis | Grade of Effort Intolerance | | F.E.V. _{1.0} (l.) (adjusted for height) | |
|-------------|-----|-----|-------------------|-----------------|--|---------------------------------------|-----------------------------|---------|---|---|
| | | | | Winding | Other | | Monday | Weekend | Observed ¹ | Expected F.E.V. _{1.0} without Byssinosis |
| 844 | F | 59 | Lancashire beamer | 45 | — | Three attacks, last aged 58 years | III | II | 1.29 | 1.78 ² |
| 901 | F | 52 | Abbott winder | 28 | 4 | Nil | I | I | 1.72 | 2.08 ² |
| 902 | F | 42 | Abbott winder | 16 | 6 | Nil | II | II | 1.90 | 2.30 ² |
| 855 | F | 44 | Abbott winder | 28 | — | One attack, aged 42 years | III | III | 1.39 | 2.30 ² |
| 946 | F | 34 | Abbott winder | 13 | — | Nil | II | II | 1.78 | 2.58 ² |
| 7 | M | 61 | Winding room | 45 | 5 (1½ blow & card room, 3½ spinning) | Three attacks in the last three years | V | III | 1.36 | 2.95 ³ |

¹All F.E.V.s were measured on Monday before work except for patient 946 whose F.E.V. was measured on Tuesday at 11.30 a.m.

²For all the women these are the mean values for workers in the same age group without symptoms of byssinosis.

³For the man the figure is the expected normal value for his age and height derived from the nomogram by Kory, Callahan, Boren, and Syner (1961).

Disabling Byssinosis The occupational and clinical histories of the six workers (five women and one man) with grade 2 byssinosis are given in the Appendix (p. 131) and summarized in Table V. The F.E.V.s in Table V (except for patient 946) were measured before work on a Monday and therefore could not have been influenced by the acute effects of exposure to cotton dust. The female workers have substantially lower F.E.V.s than workers of similar age without byssinosis. The male worker with grade 2 byssinosis also shows a substantial reduction in F.E.V. Four of the women and the male worker had effort intolerance at the week-ends. Thus from the evidence of this survey, five of the winding room workers appear to have reached the stage of byssinosis characterized by chronic respiratory embarrassment, in which demonstrable degenerative changes in the lungs have occurred, and are suffering from disabling byssinosis as defined by the Ministry of Pensions and National Insurance (1956). All had spent at least 13 years in winding rooms. Two had spent a relatively short period of employment in card or blow rooms. At present, these workers are not eligible for benefit under the Industrial Injuries Act because there is no insurance cover for occupations beyond the process of carding.

Prevalence of Byssinosis Symptoms and Dust Conditions in Card and Ring Rooms The results in the winding room may be compared with those in the card and ring rooms of the same mill.

The prevalence of byssinosis in the card room (20.5%) is similar to that in the winding rooms (18.8%), but in the latter there is a higher proportion of workers with more severe symptoms (Table VI). Dust concentrations are also higher in the winding room than in the card room. In the ring room, the prevalence of byssinosis is only 6.6%; and dust concentrations are also much lower than in the other two rooms.

Discussion

The results show that a substantial risk of byssinosis exists among the winding room workers seen in this survey. More than one in six (26 out of 146) had symptoms of the disease. Of the six who had more severe symptoms, five showed evidence of permanent effort intolerance. In addition to the clinical evidence based on the history of Monday symptoms and effort intolerance, there was confirmatory evidence of a hazard to health from the results of the ventilatory capacity tests. In the

TABLE VI
PREVALENCE OF BYSSINOSIS AMONG FEMALE WORKERS IN CARD, RING, AND WINDING ROOMS
AND MEAN DUST CONCENTRATIONS

| Room | No. Employed | Grades of Byssinosis (no.) | | | | Total with Byssinosis | | Mean Dust Concentration (mg./m. ³) | | | | |
|--------------|--------------|----------------------------|---------------|----|---|-----------------------|------|--|------|--------|--------|-------|
| | | 0 | $\frac{1}{2}$ | 1 | 2 | No. | % | No. of Samples | Fine | Medium | Coarse | Total |
| Card room .. | 112 | 89 | 11 | 10 | 2 | 23 | 20.5 | 36 | 0.44 | 1.20 | 1.21 | 2.85 |
| Ring room .. | 121 | 113 | 4 | 3 | 1 | 8 | 6.6 | 25 | 0.06 | 0.29 | 1.21 | 1.56 |
| Winding room | 117 | 95 | 9 | 8 | 5 | 22 | 18.8 | 76 | 0.52 | 1.40 | 1.56 | 3.48 |

sample of 28 workers tested at the beginning and end of the shift, there was a mean fall in F.E.V. during both shifts, indicating that there were acute effects of dust exposure. The permanent effects on ventilatory capacity are more difficult to assess from the results in Fig. 4, because some of the F.E.V.s measured during the work shift will have been diminished by the acute effects of dust exposure. However, the five workers with grade 2 byssinosis, who had their F.E.V.s measured before work on a Monday, had substantially lower F.E.V.s than expected, indicating that their exposure to cotton dust has had a permanent effect on ventilatory capacity.

The dust concentrations in the winding room were higher than those in the card room and well above the threshold limit value. In the ring room, where byssinosis had a relatively low prevalence and did not present a serious problem, the dust concentration, at 1.56 mg./m.³, was closer to the threshold limit value, providing confirmatory evidence that exposures of less than 1 mg./m.³ are likely to be reasonably safe.

There does not seem to have been any previous enquiry into either the prevalence of byssinosis or the dust concentration in winding rooms. This is no doubt due partly to the fact that byssinosis is not compensatable in the cotton industry among workers in processes beyond the cotton, blow, and card rooms. Since recent enquiries, reported by the Ministry of Pensions and National Insurance (1960), revealed that byssinosis is not a serious problem in spinning rooms it is perhaps understandable that it was assumed that there is no risk in processes after spinning.

It is clear from the present enquiry that the amount of dust liberated during winding may be much greater than that liberated during spinning. This is likely to be the result of the much higher speeds of machines now operating in winding rooms. The recent increases in speeds of the carding engines may also have reduced the amount of dust removed

from the cotton in the card room, thus allowing more dust to be liberated in the later processes. Dust adhering to the yarn comes off in relatively small quantities in ring spinning but in much larger quantities in high-speed winding and beaming.

In the mill in which this survey was made, it is clearly necessary to incorporate efficient ventilating systems or other means of dust reduction. In winding rooms of the industry as a whole, further studies should be carried out, particularly where high-speed machinery has been introduced, to assess the health risk and the need for medical surveillance and dust control. Additional evidence of high dust concentrations and respiratory disability due to byssinosis would also indicate the need to extend the compensation scheme for byssinosis to include winding room workers.

We are indebted to the management, workers, and the welfare officer of the mill. Without their co-operation, the survey could not have been made.

We also wish to thank Dr. Tyrer and his staff, of The Rochdale Industrial Health Service, and Mr. Ivey, Secretary to The Rochdale and District Weavers, Winders, Beamers, Reelers and Doublers Association for their help; Miss Joan Walford for statistical advice and help in preparing this paper; Mr. R. Pryce and Mr. M. Mohiuddin for assistance with the dust sampling; and The Cotton Board for photographs of the processes.

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APPENDIX

The following are the case notes of six winding room workers with byssinosis.

Case 1 (844) A woman aged 59 has worked for 19 years as a Lancashire speed beamer and previously for 26 years as a cone and bobbin winder. She has had three attacks of bronchitis, the first aged 35 and the last aged 58 years. She has a persistent cough without phlegm and is a non-smoker. Six years ago she noticed chest tightness and breathlessness on Mondays. She now has these symptoms on every working day with moderate effort intolerance (grade III) on Mondays, and is short of breath (grade II) at the weekends.

Her mean F.E.V._{1.0} taken on two Mondays before work, was 1.29 l. after adjustment for standing height. The mean adjusted F.E.V._{1.0} for women winders in the same age group without byssinosis was 1.78 l. (see Table IV).

Her mean change in F.E.V._{1.0} during two Monday shifts was -0.25 l.

Case 2 (901) A woman aged 52 started working in the cotton industry as a ring spinner. After four years she moved to the winding room and worked as a cone and bobbin winder for 15 years and then as an Abbott winder for 13 years. She smoked for 18 years but gave up four years ago. She has had no chest illness apart from byssinotic symptoms which first occurred on Mondays only but have recently extended to Tuesdays. She has no effort intolerance.

Her mean F.E.V._{1.0} taken on two Mondays before work, was 1.72 l. after adjustment for standing height. The mean adjusted F.E.V._{1.0} for women winders in the same age group without byssinosis was 2.08 l. (Table IV).

Her mean change in F.E.V._{1.0} during two Monday shifts was -0.29 l.

Case 3 (902) A woman aged 42 worked in the card room for six years as a back tenter and then moved to cone and bobbin winding for 11 years. See transferred to Abbott winding five years ago. She has smoked about 50 cigarettes a week for the last 28 years. She had one attack of bronchitis before she left school. For the last two years she has had chest tightness every Monday with slight effort intolerance (grade II). Recently the chest tightness has extended to Tuesdays and she has had slight effort intolerance at the weekends.

Her F.E.V._{1.0} taken on one Monday before work was 1.90 l. after adjustment for standing height. The mean adjusted F.E.V._{1.0} for women winders in the same age group without byssinosis was 2.3 l. (Table IV).

Her change in F.E.V._{1.0} during one Monday shift was -0.34 l.

Case 4 (855) A woman aged 44 has worked for seven years as an Abbott winder, and previously for 21 years as a cone and bobbin winder. She had one attack of bronchitis when she was 42 and now has persistent cough and phlegm. She has been smoking an average of 40 cigarettes a week for the last 28 years. About three years ago she noticed chest tightness on every Monday as well as on Tuesdays and Wednesdays. The tightness and breathlessness start first thing in the morning and get worse at work and continue into the evening. The tightness on Tuesdays is not as bad as on Mondays; it eases as the week goes on and disappears on Thursdays. She has grade III effort intolerance at week-ends as well as on Mondays. Her mean F.E.V._{1.0} taken on two Mondays before work was 1.39 l. after adjustment for standing height.

The mean F.E.V._{1.0} for women winders in the same age group without byssinosis was 2.30 l.

Her mean change in F.E.V._{1.0} during two Monday shifts was -0.06 l.

Case 5 (946) A woman aged 34 came to this country 18 years ago from central Europe. She started in a cotton mill when she was 21 and worked as a cone and bobbin winder for seven years, then moved to Abbott winding where she has been for the last six years. She has been smoking 160 cigarettes a week for the last 20 years and gets occasional cough and phlegm, but neither of these is persistent. She had an attack of pleurisy when she was 31. Eighteen months ago she noticed chest tightness on all working days at the end of the work shift. It lasts for two hours. She has no symptoms of chest tightness on Saturdays and Sundays. She has slight effort intolerance at weekends as well as on Mondays.

Her F.E.V._{1.0} taken on a Tuesday at 11.30 a.m. was 1.78 l. after adjustment for standing height. The mean F.E.V._{1.0} for women winders in the same age group without byssinosis was 2.58 l. Her change in F.E.V. during the shift was not measured.

Case 6 (7) A man aged 61 had worked for 45 years in the winding room and previously in other parts of the mill for five years, of which 18 months was spent in card and blow rooms. He has had recurrent attacks of chronic

bronchitis, the first aged 48 and three attacks during the past three years. He has persistent cough and phlegm. For the last five years he has had chest tightness on Mondays from 10.00 a.m. to 3.30 p.m. on the morning shift, and from 7.00 p.m. to 10.30 p.m. on the afternoon shift. Chest tightness and breathlessness have now extended to all working days, easing on Thursdays and Fridays. These symptoms disappear completely during his annual fortnight's holiday. He has moderate effort intolerance (grade III) at the weekends but it is very severe on Mondays.

He has smoked 160 cigarettes a week for the last 38 years, but during the last two months he has reduced his consumption to 90 per week because of his chest symptoms.

His mean F.E.V._{1.0} taken on two Mondays before work was 1.36 l. after adjustment for standing height. The expected value for a man of his height and age is 2.95 l. His mean change in F.E.V._{1.0} during two Monday shifts was only -0.06 l. Because of his chest symptoms he has recently taken every possible step to keep away from the dust.