self from employment so that no adverse effect can be statistically demonstrated in those remaining. We believe this to be unlikely, since this phenomenon has not eliminated significant differences in other segments of the cotton industry. Furthermore, two of the authors with more than 38 combined years of pulmonary practice in the San Joaquin Valley have failed to identify a single case of byssinosis. This negative experience was confirmed by a survey of more than 440 San Joaquin Valley physicians who might have had an opportunity to care for cotton gin workers.

SUMMARY

No excess of obstructive airway disease was found in a group of 265 cotton gin workers when compared with other San Joaquin Valley agricultural workers. After an average of eight weeks' employment in San Joaquin Valley cotton gins, 125 workers showed no appreciable deterioration of pulmonary function compared with pre-employment measurements.

In studies of pulmonary function during a workshift, cotton gin workers showed slightly greater mean decrements than control agricultural workers. These differences did not reach a level of statistical significance and were lower than those usually found in byssinosis.

The unusual temporal pattern of employment in cotton gins in California precludes a simple approach to diagnosis by symptoms. No correlation was found in this study between symptoms of byssinosis and objective decrements in FEV₁. The questionnaire as proposed by the Cotton Dust Standard was found to be of no value in detecting reactors in this study of gin workers.

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The Relation of Lung Function to Subsequent Employment Status and Mortality in Cotton Textile Workers*

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Long-term occupational exposure to cotton textile dust has been associated with the development of chronic obstructive lung disease.¹ ² We investigated the relation of lung function in cotton textile workers to their subsequent employment status and mortality. We wanted to determine whether lung function in cotton textile workers who died or retired from the mill before age 65 years differed from lung function in those still active in the mill. Although many studies have investigated lung function in active cotton textile workers, only one (our previous study³) has examined lung function in retired workers. Our findings in the present study are based on the previous cross-sectional one as well as on the follow-up study of these same older active and retired textile workers in Columbia, SC.

SUBJECTS AND METHODS

Our original study population of cotton textile workers included anyone who had worked for at least three years before 1955 in one or more of four mills in the Columbia, SC, area. Of the initial 692 workers studied in 1973, ¹ we re-examined 408 in 1979, and an additional 80 were determined to have died between the two surveys. For comparison with the textile workers, we used as controls a like-aged population of nontextile workers from Lebanon,
Table 1—Distribution of Follow-up Populations by Sex and Work Status in 1973 and 1979, Whites Age 45-64 Years

<table>
<thead>
<tr>
<th>Controls (C)</th>
<th>Active-Active (A-A)</th>
<th>Active-Retired (A-R)</th>
<th>Retired-Retired (R-R)</th>
<th>Deceased (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>133</td>
<td>51</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>Females</td>
<td>124</td>
<td>50</td>
<td>54</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>257</td>
<td>101</td>
<td>98</td>
<td>89</td>
</tr>
</tbody>
</table>


Conn, whom we studied with similar methods in 1972 and again in 1978. The interval between studies was about six years for both controls and cotton textile workers.

Those who responded to the follow-up surveys were compared with those who did not respond (excluding the deceased) in each of the two studies, Lebanon and Columbia. Comparisons were made within sex, age, and smoking groups. Only isolated differences between respondents and nonrespondents were found when comparisons were made on 13 symptoms and on two lung function measures.

Almost all of the cotton textile workers were white and older than 45 years. For the present study dealing with work status before the age of 65, we will limit the population to whites, ages 45 to 64 at the time of the original survey. The 330 textile workers meeting these criteria and followed up six years later are classified by sex and work status in Table 1. Active implies currently working in the mill; retired implies no longer working in the mill. The pairs A-A, A-R, and R-R refer to work status in 1973 and 1979, respectively. Excluded from the study were four workers who were retired in 1973, but who were again active in the mill in 1979. Deceased are those cotton textile workers examined in 1973 who died before the study in 1979. Table 1 also gives by sex the 237 white controls, 45 to 64 years of age, followed up in Lebanon.

A comparison of the smoking statuses among textile workers and controls for men and women is given in Table 2. The frequency distributions of smoking habits for cotton textile workers and controls do not significantly differ for men. However, for women there is a marginally significant difference (P = .053) owing to the fewer exsmokers (9 percent) among the textile workers than among the controls (20 percent). To control for any possible smoking differences, separate analyses were also done, classified by smoking habit. For amount and place of any text that is not clearly readable.
Figure 2. Mean (±SEM) residual lung function (rFEV₁) in 1973 by work status in 1973 and 1979 in white male non-smokers age 45-64 years.

(P < .0005) from each of the cotton textile worker groups. Within textile workers, the active-active and active-retired groups have less loss than the deceased group (P < .001), and the retired-retired group has greater loss of FEV₁ than the active-active group (P = .016). The same pattern occurred when the analysis was done for residual MEF50%.

The relationship of lung function loss in terms of FEV₁ and work status and mortality within men was further examined separately for nonsmokers, exsmokers, and smokers. The same general pattern as observed in all men was found in each of the smoking status groups. The results in nonsmoking men are shown in Figure 2. As with all men, the differences among the groups were very significant (P = .003). The control and active-groups differed from the deceased group (P = .003 and .01, respectively), while the con-

Figure 3. Mean (±SEM) residual lung function (rFEV₁) in 1973 by work status in 1973 and 1979, in white women age 45-64 years.

controls differed only marginally from the retired-retired group (P = .054).

This trend in lung function decrement across work status groups is not due to differences in the length of cotton dust exposure or amount smoked. There was no increase (or decrease) in mean number of years worked in the mill across work status groups. For men, the largest median number of years worked in the mill occurred in the active-retired group except for the smoker subgroup. For smokers, the deceased group had the largest length of exposure (38.8 years), but this was nearly the same as in the active-retired group (35.7 years). There was an increasing trend in amount smoked in pack-years across work status groups. (One pack-year = 20 cigarettes smoked per day for one year.) However, the means did not differ significantly between controls and cotton textile workers except in exsmoking retired-men. When adjusting for pack-years with an analysis of covariance, the significant differences in rFEV₁ among work status groups remained as before.

A similar analysis for women was done to relate lung function in 1973 with work status. The results for all women combined are shown in Figure 3. There are significant differences (P < .0001) in mean rFEV₁ among the five groups shown; however, the trend seen in men is no longer present. The controls differ significantly from each of the cotton textile worker groups (P < .02) but the latter do not differ among themselves. When analyzed separately for the three smoking status groups, no general trends appear. For example, the results for women nonsmokers are shown in Figure 4. Here the active-retired workers have the largest decrement in FEV₁ and are different from controls (P < .0001) and from the active-active group (P = .035). The retired-retired group differed from the controls (P = .017) but not from the other groups, while the deceased (only four of them) did not show a significant loss. The same results occurred when residual MEF50% was analyzed.
The degree of loss in FEV$_1$ over the various work status groups in women is not explained by differences in mean length of work in the mill or pack-years. The mean lengths of work for all women in the active-retired and deceased groups were nearly identical (38 years); and they were larger ($P < .06$) than the means for each of the other two groups (31 years). The same pattern occurred in nonsmoking women. The amount smoked in pack-years did not differ among any of the work status groups and the control group. Therefore, the amount smoked does not explain the lung function differences found between the controls and the cotton textile worker groups in women.

In addition to residual lung function, we used categories of partial and total disability as defined previously to relate pulmonary dysfunction to work status. The percentages of cotton textile workers with partial disability or total disability in 1973 or 1979 were compared with the percentages in the controls. Figure 5 shows increasing percentages ($P < .0001$) of totally disabled persons in 1973 and in 1979 across the work status groups. When analyzed separately for nonsmokers, exsmokers, and smokers (based on the smoking status in the same year as disability was determined), similar trends of increasing total disability occur. In addition, for cotton textile workers, the percentages of disability in 1979 are always higher than in 1973.

The prevalences of partial disability in 1973 and 1979 by work status are shown in Figure 6. There is no increasing trend of the percentages of disability across the work status groups of cotton textile workers. There are, however, highly significant differences ($P < .004$) in the percentage of partially disabled persons between the control group and each of the cotton textile worker groups for both 1973 and 1979. The same pattern holds when looking at the percentages of partially disabled for each of the three smoking status groups used before.

**Discussion**

We have shown that white cotton textile workers age 45 to 64, regardless of work status, have lower mean lung function than a control population of non-textile workers. This result could not be explained by differences in numbers of smokers or exsmokers or in

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**Figure 5.** Percent totally disabled (FEV$_1$ < 50% pred) in 1973 and 1979 by work status, whites aged 45-64 years.

**Figure 6.** Percent partially disabled (50% pred ≤ FEV$_1$ < pred − 1.96 SE) in 1973 and 1979 by work status in whites age 45-64 years.
Respiratory Health in Cottonseed Crushing Mills


This presentation summarizes our experience in three cross-sectional studies of respiratory health in cottonseed crushing mills. These studies were done in 1975, 1977, and 1978. Three mills were visited on all three occasions, another twice, and another once. In the course of these studies, health data were collected on a total of 444 subjects in the five mills.

In the United States, crushing mills receive cottonseed directly from the gins, with fibrous linters firmly adherent to each seed. This fibrous portion is contaminated with bracts, stems, dirt, and other contaminants similar to those of baled cotton fiber. The major steps in production include storage, removal from storage, cleaning with mechanical shakers, delinting with circular saws, hull removal with mechanical knives, cooking of meats, oil extraction by press or solvent extraction, and production of cake or meal from the meat residue. Linters, hulls, oil, cake, and meal are all of commercial value and are processed for storage and shipment.

The dryness of most of the products and the application of high velocity mechanical force at several steps in processing result in dustiness of the workplace. Table 1 summarizes some results of 486 air samples taken in the first study in 1975. Mean dust levels are presented for various areas (elutriated dust) and several jobs (total dust obtained by personal dust sampler) in four mills. Many of these values are clearly in excess of the 0.5 mg/m³ standard promulgated by the US Department of Labor for nontextile cotton dust exposures. Our initial attempt to quantify exposure was to characterize jobs as having high, intermediate,