# RESPIRATORY SYMPTOMS AND LUNG FUNCTION IN JUTE PROCESSING WORKERS: A PRIMARY INVESTIGATION

**ZHOU CHEN, M.D. • Zenlin Liu, M.D. • Chinshan Ho, M.D. • Jiezhi Lou, M.D.**

Department of Public Health, China Medical University, Shenyang, People's Republic of China

## INTRODUCTION

Effect of vegetable dusts on the workers' health has been noticed for many years, but only in recent years has much attention been paid to this occupational problem.[1,2,3] Although there have been a few studies on the health effect of jute dust, little information was available for the chronic effect of jute dust exposure. In the early 1960s, Mair et al and Gilson et al found no "Monday" symptom and no acute lung function injury in jute-dust exposed workers in Britain.[4,5] But a few investigators had reported lung function decrement in the first working shift and atypical chest tightness in jute processing workers in other countries.[6-8] In this report, we conducted an industrial hygiene survey and respiratory symptoms investigation as well as lung function measurements to verify if there was any occupational lung disease problem in the China jute industry. We also attempted to explore the possible mechanisms of the lung injury in this industry.

## SUBJECTS AND METHODS

### Subjects

404 jute exposed workers were included in the study. The criteria for selecting workers for examination were: (1) at least one year of dust exposure; (2) without asthma, tuberculosis, heart disease; and (3) no current respiratory infection. Among these workers, 217 were male, 187 were female. The control group contained 396 workers coming from the same city and had jobs of similar labor intensity but had not been exposed to toxicant or dust. Among these workers, 236 were male and 160 were female.

### Questionnaire

Because the workers rest 24 hours after working for three days, the medieal examinations were carried out before the beginning of the first working day. The workers were questioned about their respiratory symptoms by a trained physician. The questionnaire was based on the MRC respiratory symptom questionnaire with emphasis placed on the chronic respiratory symptoms and chronic lung diseases as well as occupational exposure history. Measurement of body weight and height were also conducted.

### Lung Functions

Spirometry was performed using a waterseal spirometer. The subject performed the maximum expiratory flow-volume curve and repeated the performance until at least three acceptable curves were obtained. Subjects who did not have acceptable curves were excluded. Lung function analysis was performed on the curve with largest value. Forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1.0}$), and $FEV_{1.0}$/FVC were measured. Measurements were converted to BTPS. Multiple regression equations were established by use of lung function data from control workers who had no respiratory symptom. When establishing the regression equations, age, height, body weight, smoking and sex were considered as variables. The predicted values of lung function of all workers were calculated according to the established equations. The lower limits of abnormal values were 0.80 for predicted FVC, and 0.75 for predicted $FEV_{1.0}$/FVC. The criteria for selecting abnormal of predicted $FEV_{1.0}$ were selected according to WHO's suggestion: >0.80, normal; 0.79–0.60, slight or moderately abnormal; <0.60, severely abnormal.

### Industrial Hygiene Investigation

The jute mill studied consists of two parts: a weaving factory producing jute sacks and a spinning mill producing fine rope. The jute was brought to the mill from various regions in China and then was processed in the following steps: mixing, softening the fiber with mineral water and pressed through a "softener," carding, roving, spinning, winding, weaving, and finishing. The manufacturing procedures in the weaving factory and in the spinning mill were quite similar except no weaving and finishing existed in the spinning mill. Total dust concentration was measured by area sampling. A total of 106 samples were obtained. The dust levels indicated in this paper were the arithmetic means of the time weighted average values for the locations sampled in each workplace.

## RESULTS

### Dust Concentration and Its Chemical Composition

The dust concentration in different jute processing areas is shown in Table I. Dust concentrations in spinning mills were higher than those in weaving factories The mixing, softening procedure produced very high levels of dust, and dusts in these areas contained high mineral material and high silica (13.3%–14.3%). Dust levels in other areas were lower than 5 mg/M$^3$ and contain low mineral material and less than 5% silica. After averaging the results of dust distribution from different workplaces, we found 65.1% of particles were under 5$\mu$m; 23.5% of particles were between 5.0 to 10.0$\mu$m; only 12.4% particles were larger than 10$\mu$m. This result indicated

Table I
Dust Concentration and Its Chemical Composition in Jute Mills

| Procedures | Total dust ($mg/M^3$) weaving factory | spinning mill | Ash (%) | Silica (%) |
|---|---|---|---|---|
| mixing#* | 35.6 | 53.6 | 50.9 | 14.3 |
| softening#* | 48.5 | 120.3 | 25.4 | 13.4 |
| carding#* | 4.0 | 6.8 | 12.6 | 6.2 |
| spool#* | 1.5 | 1.8 | 1.6 | 1.6 |
| copping# | 1.8 | - | 1.8 | 1.8 |
| roving* | - | 1.9 | 20.9 | 1.8 |
| Spinning#* | 4.9 | 8.6 | 8.3 | 1.1 |
| copping* | - | 20.4 | 5.8 | 1.4 |
| winding* | - | 0.9 | 12.2 | 1.3 |
| weaving# | 1.6 | - | 11.1 | 2.3 |
| finishing# | 2.2 | - | 5.8 | 1.5 |

#:manufacturing procedure in weaving factory
*:manufacturing procedure in spinning mill

that most jute dusts in this mill were inhalable.

## Respiratory Symptoms

In order to find the chronic effect of jute dust exposure, we included many workers who had been employed more than 20 years or were ex-workers. This resulted in a difference in the age distribution between two groups. The exposed group had more workers who were over 50 years old. There were nearly 40% of workers who had been exposed to dust for more than 20 years. So, standardization method (chi square test for comparison of rates with inner distribution difference) was used to compare the respiratory symptoms between two groups. Figures 1 to 3 show the results of the comparison. Because few female smokers exited in both groups, comparison of the symptoms was only conducted in female nonsmokers. Prevalence of all the respiratory symptoms were higher in exposed groups than in control groups. Exposed workers had significantly higher prevalence of cough, chest tightness symptoms than control workers in both male smokers and nonsmokers groups. In exposed female nonsmokers, the prevalence of cough, bronchitis, chest tightness and dyspnea were also significantly higher when compared with those of control female nonsmokers. We also compared the prevalence of respiratory symptoms in smokers and nonsmokers. In exposed male, the prevalence of cough and bronchitis were significantly higher in smokers than those in nonsmokers ($X^2 = 6.09$, $P<0.05$; $X^2 = 5.54$, $P<0.05$). In control male workers, the smokers had significantly higher prevalence of cough compared with nonsmokers ($X^2 = 12.1$, $P<0.01$).

## Lung Function

The abnormal of lung function was evaluated by the percentage of predicted value. Table II shows the results of the comparison of abnormal rates of FVC, $FEV_{1.0}$, $FEV_{1.0}$/FVC between the exposed workers and control workers. The abnormal rates of FVC, $FEV_{1.0}$ and $FEV_{1.0}$/FVC were significantly higher than those in exposed workers. Comparing with control workers, the exposed workers had increased 3.2% abnormal rate in FVC; 12.9% abnormal rate in $FEV_{1.0}$, 7.5% abnormal rate in $FEV_{1.0}$/FVC. 5.4% of exposed workers had severe abnormality of $FEV_{1.0}$.

Because smoking is an important factor in causing lung dysfunction, we used $FEV_{1.0}$ to analyze the effect of smoking on lung function. $FEV_{1.0}$ was selected since it is an important index to evaluate the permanent lung function injury due to vegetable dusts.[1] The comparison of abnormal of $FEV_{1.0}$ between male smokers and nonsmokers in exposed and control groups were shown in Table III. Odd ratios were calculated to analyze the contribution of smoking and dust exposure to abnormality of lung function. The results indicated both dust exposure and smoking would cause lung function loss, but dust exposure was much more effective than smoking. Dust exposure and smoking had combined effects in increasing abnormal rate of $FEV_{1.0}$.

## DISCUSSION

Recently, more attention has been paid to the chronic effect of vegetable dust.[1,2,9] Some investigators have studied chronic effects of cotton, flax dusts.[9,10,11,12,13] They found permanent lung injury in cotton workers.[10,11,12] The permanent lung injury or loss of lung function may not necessarily come from "Monday" symptom and acute reversible lung function decrement.[2] In our study, we found jute dust exposure caused increased prevalence of caught, chest tightness in exposed male workers (both smokers and nonsmokers) and increased prevalence of caught, chest tightness, chronic bronchitis, dyspnea in female workers (nonsmokers). Among

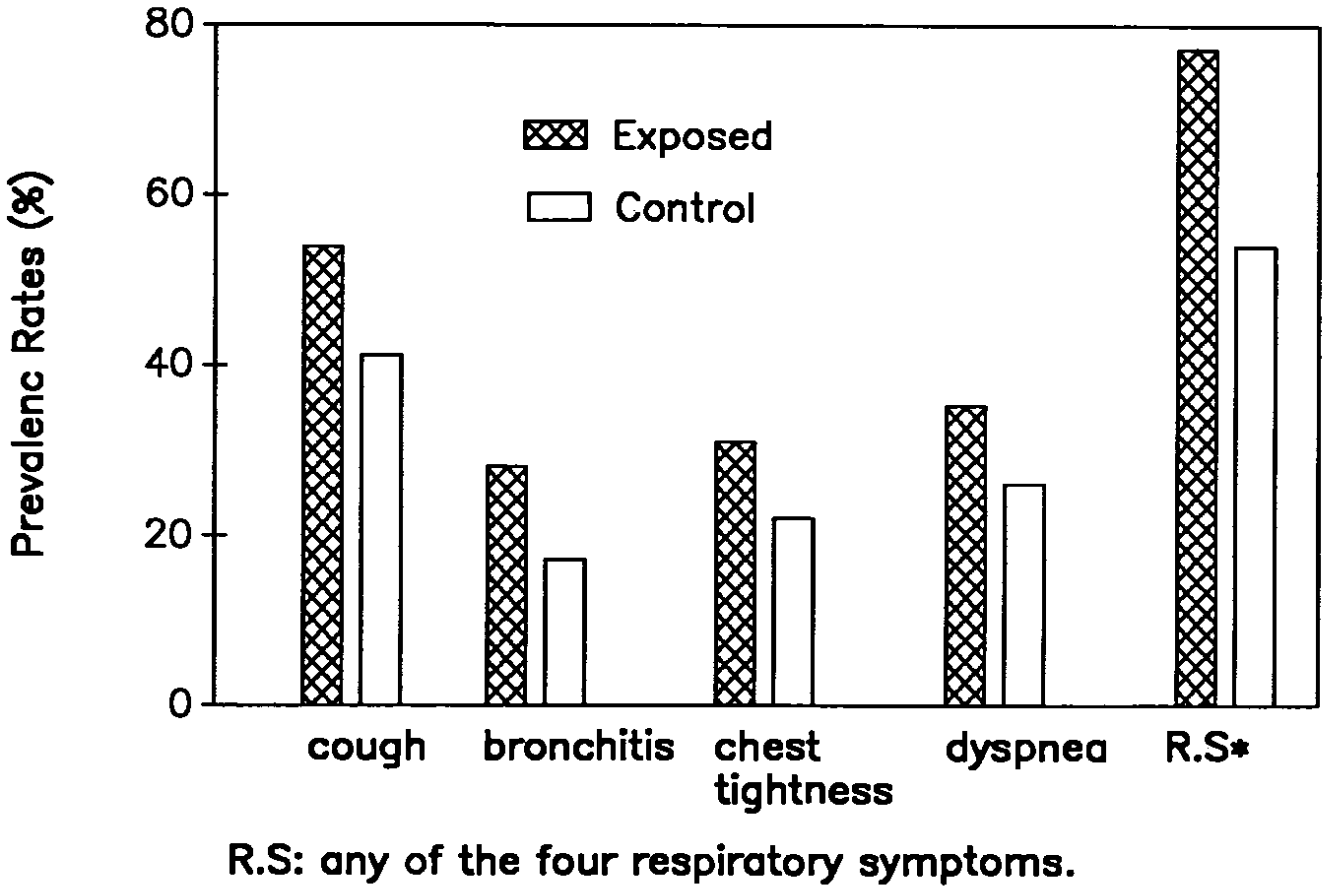


Figure 1. The prevalence of respiratory symptoms in male smokers.

Table II

Comparison of Rates of Abnormality of Percentage of Predicted Value of FVC, $FEV_{1.0}$, $FEV_{1.0}$/FVC between Exposed and Control Workers

| Lung function | Percent predicted values | Exposed workers No. | Exposed workers % | Control workers No. | Control workers % | $X^2$ | P |
|---|---|---|---|---|---|---|---|
| FVC | >0.80 | 331 | 93.5 | 356 | 96.7 | 4.1 | <0.05 |
| | <0.80 | 23 | 6.5 | 12 | 3.3 | | |
| $FEV_{1.0}$ | >0.80 | 276 | 78.0 | 334 | 90.8 | 22.7 | <0.01 |
| | 0.60-0.79 | 59 | 16.7 | 27 | 16.7 | | |
| | <0.60 | 19 | 5.4 | 7 | 1.9 | | |
| $FEV_{1.0}$/FVC | >0.75 | 328 | 89.8 | 358 | 97.3 | 26.1 | <0.05 |
| | <0.75 | 36 | 10.2 | 10 | 2.7 | | |

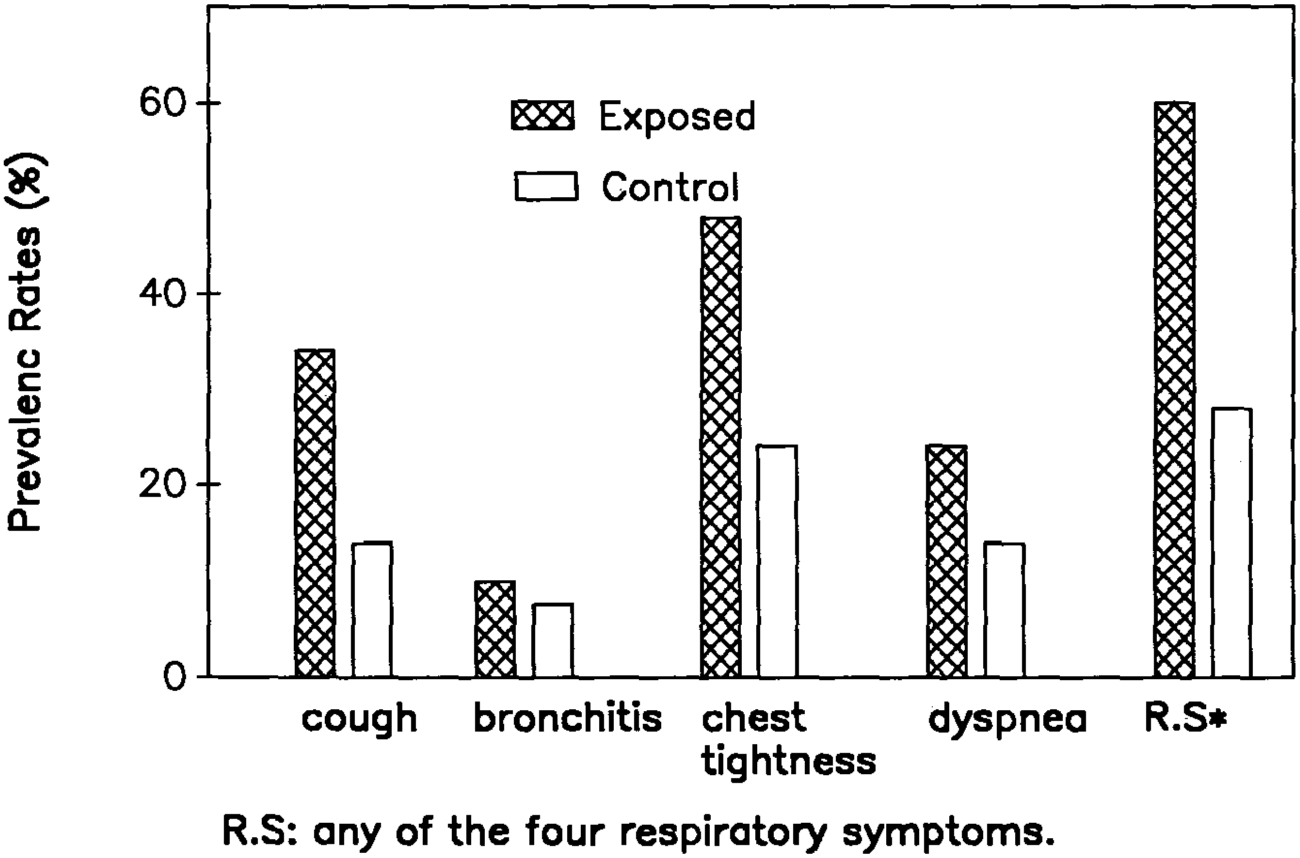


Figure 2. The prevalence of respiratory symptoms in male nonsmokers.

Table III
Contribution* of Dust Exposure and Smoking to Lung Dysfunction Expressed by Abnormal Rate of Percent of Predicted Value of $FEV_{1.0}$

| Dust exposure | Smoke | Abnormal rate of $FEV_{1.0}$ <0.80 | >0.80 | Odd ratio (OR) |
|---|---|---|---|---|
| - | - | 5 | 58 | 1.00 |
| - | + | 13 | 149 | 1.01 |
| + | - | 10 | 37 | 3.14 |
| + | + | 45 | 111 | 4.70 |

* $OR_{dust}+OR_{smoking}=4.15$ $OR_{dust+smoking}=4.70$
$OR_{dust+smoking}>OR_{dust}+OR_{smoking}$

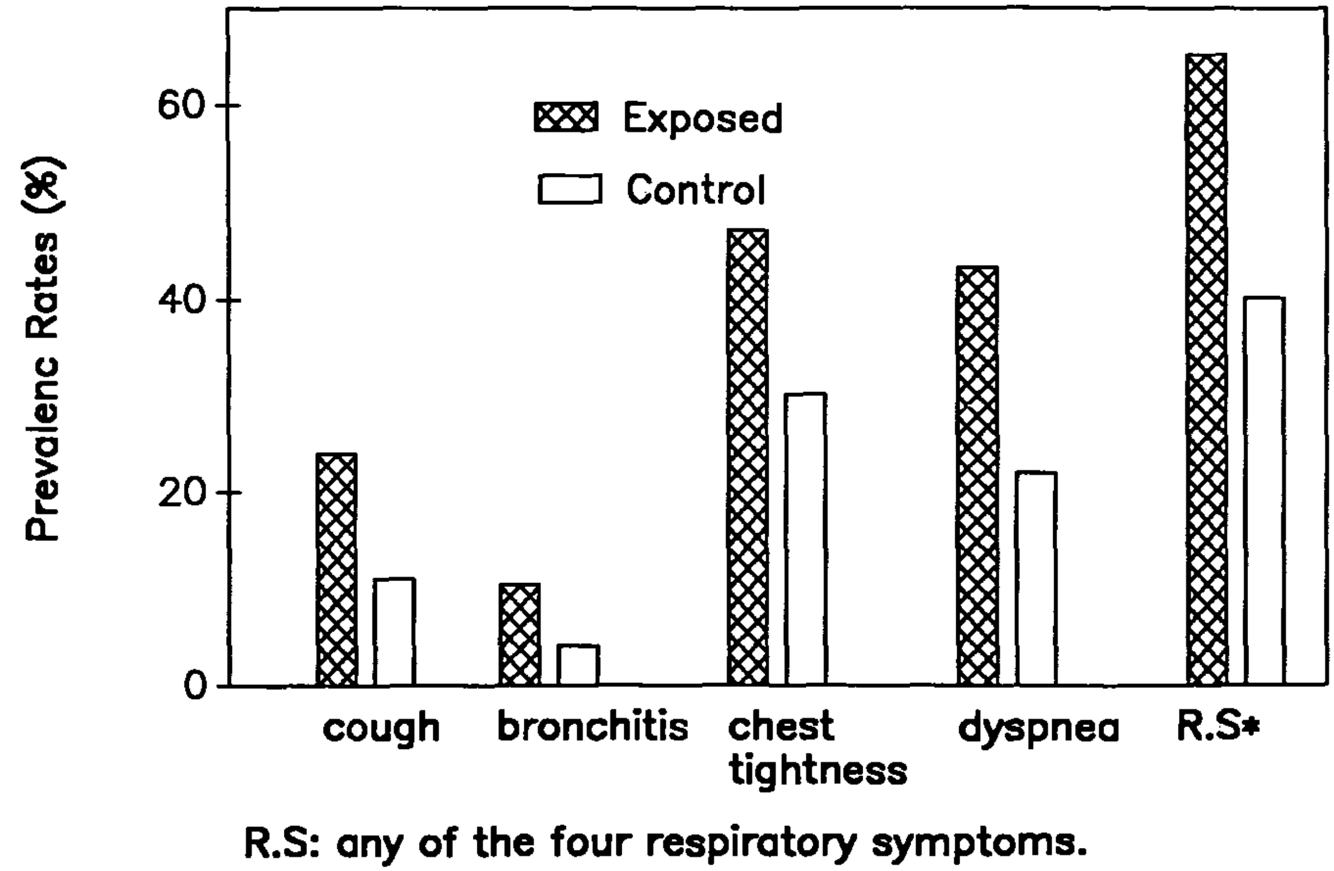


Figure 3. The prevalence of respiratory symptoms in female nonsmokers.

exposed workers, cough and chest tightness not only occurred on Monday, but also occurred in other working days. Smoking itself only caused a higher prevalence rate of cough in both exposed and control groups. With dust exposure, smoking caused a higher prevalence of chronic bronchitis. This means smoking was not the main cause of all these symptoms. The atypical chest tightness and chronic bronchitis were the main clinical symptoms in jute processing workers. There was no typical "Monday" symptom in our study. These findings were similar to the report from Ghawabi, E. L. et al.[6]

Valic, F. et al reported acute lung function loss in nonsmoking female jute workers.[7] Ghawabi et al, Gandevia and Milne found the acute decline of $FEV_{1.0}$ in the first working shift in jute processing workers.[6,8] We also found jute processing workers had significantly higher abnormal rates of FVC, $FEV_{1.0}$, $FEV_{1.0}$/FVC before the beginning of first working day. The abnormal rate of $FEV_{1.0}$ increased more than 12.9% and rate of severe abnormality of $FEV_{1.0}$ increased more than 3.5% in exposed workers when comparing with control workers. The reasons of difference of results between ours and Mair, A. et al may be due to higher dust levels in our study and different lung function index used. Our results indicated that there is an occupational lung disease problem in China jute industry.

Beck, G. J. et al reported cotton dust and smoking have combined effect in causing the lung function loss.[11] We had also found that jute dust and smoking has such an effect. Jute dust exposure was a main cause for abnormality of lung function, but smoking would increase the abnormal rate of lung function caused by dust exposure. We, therefore, concluded that the chronic lung injury in jute processing workers may be mainly due to high level and long duration of jute dust exposure. Our results of industrial hygiene investigation show that jute processing is a very dusty industry. The early steps of processing of jute, especially the mixing and softening procedures produced high levels of dust which contained considerable amounts of ash and silica. The results of high levels of dust in these areas was from manual operation, and high content of ash and silica were associated with earth or dirt on the surface of jute fiber. The other procedures also produced about 2 to 5 mg/M$^3$ dust and most of the dusts were inhalable. The concentration was also higher than the ACGIH recommendation for cotton dust. The jute processing workers, therefore, inhaled a considerable amount of dust, which may account for their lung injury.

The mechanisms of lung disease caused by vegetable dust are very complicated because dust in the workplace is complex. Mineral impurities, special chemical component of fiber and microorganisms are commonly believed to be main etiological factors. In our study, we found there were different mineral and silica contents in different workplaces. A few jute processing workers were exposed to dust containing 10% to 15% silica, but most workers were exposed to dust containing less than 5% silica. We analyzed the relationships between the mineral content, silica content in dusts and respiratory symptoms and lung function, no relationship was found, all correlation coefficients were below 0.50. The chest X-ray examination of workers who had worked in high level dust areas in this mill for more than 20 years showed no diagnosable silicosis or pneumoconiosis.[14] In our study, there was no evidence that mineral and silica content in jute dust were important factors in jute dust induced lung injury. The mechanism of jute dust induced lung injury may be due to special chemical components of fiber or microorganism, or it may be simply a nonspecific respiratory irritant.[3] Further study is needed to better understand the mechanism of lung injury produced by jute dust.

We concluded that jute processing is a very dusty industry. Exposure to jute dusts caused significant increase in respiratory symptoms and significant increase of abnormal rate of FVC, $FEV_{1.0}$, $FEV_{1.0}$/FVC. Smoking had an additive effect in lung function injury.

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