Respiratory function and symptoms in workers exposed simultaneously to jute and hemp

S. H. EL GHAWABI

From the National Institute of Occupational Safety and Health, Heliopolis, Cairo

ABSTRACT The environment and health of a working population exposed simultaneously to jute and hemp were studied. Classical symptoms of byssinosis were not present but 21 workers (7%) complained of atypical tightness of the chest. The prevalence of chronic bronchitis among the exposed workers was statistically significant in comparison with controls. Effects of dust concentrations, age and duration of exposure on the prevalence of chronic bronchitis were studied. A statistically significant reduction in $FEV_{1.0}$ at the end of a work shift occurred in all the exposed workers. Bronchodilators given after the shift showed that acute reductions in forced expiratory volumes were nearly fully reversible in all exposed workers. Smokers and those with chronic bronchitis had greater reductions in $FEV_{1.0}$ values at the end of the work shift.

Jute is, by volume, the second largest natural textile fibre processed in Egypt (Central Agency for Public Mobilization and Statistics, 1974). It is used mainly for products in which low cost is more important than strength and durability. Jute fibres may be used on their own, or blended with other natural fibres such as kenaf (hemp) (*Hibiscus Cannabinus*) of the Malvaceae family. The majority of previous investigators have studied the effects of these vegetable dusts as though each type occurs in isolation. Thus, byssinosis has been described as occurring in some exposed workers as a result of hemp processing (Bouhuys *et al.*, 1967; Valić *et al.*, 1968; Valić and Žuškin, 1972). On the other hand, apart from Popa *et al.* (1969), no-one has reported byssinosis from jute processing (Schilling, 1956; Mair *et al.*, 1960; Siddhu *et al.*, 1966; Valić and Žuškin, 1971). Normal occupational exposure is to mixtures of fibres rather than to a single type, but there are few reports describing the effects of such mixtures. Smith *et al.* (1969) and Žuškin and Valić (1973) reported the effects of simultaneous exposure to flax and hemp dusts. However, the combined effects of jute and hemp exposure have not been reported in the literature so far. The following is a survey of respiratory symptoms together with measurements of ventilatory function in workers exposed simul-

taneously to imported jute and Egyptian hemp in one of the two largest jute-processing factories in Egypt.

Methods

After excluding seven workers with tuberculosis and three workers with heart disease, a total of 311 male workers in the batting, hackling, carding and drawing sections were interviewed. Details of the present and past medical and occupational histories were obtained. An adaptation of the British Medical Research Council Questionnaire on respiratory symptoms with additional questions on byssinosis (Schilling *et al.*, 1964), was used by our interviewers. Chronic bronchitis and asthma were defined according to the Ciba Guest Symposium (1959). Other respiratory symptoms (ORS) were defined as upper respiratory symptoms not satisfying the criteria for the diagnosis of chronic bronchitis, such as frequent nasal catarrh, sinusitis and unproductive cough. After two practice recordings, a nine-litre Palmer spirometer was used to make three recordings of the forced expiratory spirogram with the subject sitting down, before and after the Saturday and Thursday work shifts. The forced expiratory volume in one second ($FEV_{1.0}$) was calculated from these tracings. The maximum of the three readings was taken, and converted according to body temperature and saturation water vapour pressure. The measurements were also repeated at the end of a work shift after the subject had taken three puffs of a bron-

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chodilator (Salbutamol) from a pocket nebuliser (Ventolin inhaler). The degree of reversibility of the reduced ventilatory capacity was determined 15 minutes after inhalation of the bronchodilator. A control group of 50 workers of similar age and socio-economic standard to the study group was chosen from the general service workers (caretakers, outdoor erection and restaurant workers) who had not been exposed to any dusty working atmosphere.

Dust samples were collected for gravimetric determination of respirable particles using a Hexhlet sampler at a constant flow rate of 50 l/min for 30 min. Total dust was collected on membrane filters mounted on vertical holders adjusted to obtain samples from the workers' breathing zones. Eighteen dust samples were collected from every workplace for examination of both respirable and total dust.

Results

Table 1 shows the distribution of workers according to type of work, age range and duration of exposure. The age range was 21-57 yr with a mean of 36.7 yr (± 9.1), while the mean age for the control group was 37.2 yr (± 8.6). The difference between the two means was not statistically significant ($p > 0.1$). The age distribution of all exposed workers in relation to the duration of exposure is given in Table 2. It was found that 34% of the exposed workers were under 30 years of age; 30% between 30 and 39; 20% in the fifth decade and 16% 50 years old or over. The duration of exposure varied from less than five years in 63 workers (20%); five to nine years in 91 workers (29%); 10-14 yr in 101 workers (33%) and more than 15 yr in 56 workers (18%).

Table 3 gives the smoking status of the men in both the exposed and control groups. As the number of ex-smokers was found to be too small for valid statistical analysis, they were added to the group of non-smokers. The difference between both the exposed workers and controls as regards smoking was not statistically significant ($p > 0.1$).

In the exposed group, no workers reported symptoms of classical byssinotic tightness (Table 4). However, 21 workers (7%) did suffer from tightness of the chest, but this bore no relation to the first day

of the working week. Such atypical tightness tended to occur after a variable period from the start of the work shift, lasting a few minutes and relieved by fresh air. At a later stage it lasted throughout all or the rest of the shift and necessitated the use of bronchodilators. The prevalence did not increase significantly with length of exposure ($0.1 > p > 0.05$, Table 5) and was not significantly correlated with dust concentration (Table 7). Such chest tightness is similar to that previously described by El Sobkey (1975) in cotton textile workers although in his subjects the prevalence of this tightness was significantly increased in more dusty occupations.

Table 2 Distribution of exposed workers according to age and period of exposure

Age range (yr)	No. of workers	Period of exposure (yr)			
		<5	5-9	10-14	15+
20-29	107	52	39	14	2
30-39	92	9	41	36	6
40-49	65	1	9	34	21
50+	47	1	2	17	27
Total	311	63	91	101	56

Table 3 Smoking status of exposed and control workers

Smoking status	Exposed workers		Controls	
	No.	%	No.	%
Smokers	152	49	23	46
Non-smokers	159	51	27	54
Total	311		50	

Table 4 Prevalence of respiratory symptoms in exposed workers and controls

Symptom	Exposed workers		Controls		P
	No.	%	No.	%	
Byssinosis	—	0	—	0	—
Atypical chest tightness	21	7	—	0	0.0093
Chronic bronchitis	66	21	3	6	0.0002
Bronchial asthma	12	4	2	4	ns
Other respiratory symptoms	22	7	1	2	0.05

ns = not significant

Table 1 Distribution of exposed workers according to type of work, age range and period of exposure

Type of work	No. of workers	Age range (yr)				Period of exposure (yr)			
		20-29	30-39	40-49	50+	<5	5-9	10-14	15+
Batting	18	3	5	6	4	2	5	7	4
Hackling	72	26	28	10	8	5	19	29	19
Carding	139	45	42	31	21	31	49	39	20
Drawing	82	33	17	18	14	25	18	26	13
Total	311	107	92	65	47	63	91	101	56

Table 5 *Chronic bronchitis and atypical chest tightness according to length of exposure*

Length of exposure (yr)	No. of workers	Chronic bronchitis		Atypical chest tightness	
		No.	%	No.	%
<5	63	5	8	1	2
5-9	91	15	16	5	5
10-14	101	24	24	8	8
15+	56	22	39	7	12

χ^2 with 3 degrees of freedom = 19.88 calculated for the prevalence of chronic bronchitis according to the duration of exposure ($P < 0.005$); for atypical tightness according to the period of exposure $\chi^2 = 6.66$ ($0.1 > P > 0.05$).

Table 6 *Chronic bronchitis in exposed workers and controls according to smoking status*

Smoking category	No. of workers	Chronic bronchitis	
		No.	%
Smokers			
Exposed	152	35	23.0
Controls	23	2	9.0
Non-smokers			
Exposed	159	31	19.0
Controls	27	1	4.0

It was found that 66 exposed workers (21%) had chronic bronchitis, which occurred in only 6% of the control group. This difference in prevalence between the two groups was statistically significant ($P < 0.0002$). The difference in smoking status between exposed and control subjects is shown in Table 6. Exposure to a mixture of vegetable dusts appeared to be a more important factor than smoking in the aetiology of chronic bronchitis.

There was a highly significant increase in the prevalence of chronic bronchitis in the more dusty atmospheres compared with the less dusty work places (39% and 40% in the batting and hackling sections respectively, while its prevalence was 16% among carders and 10% among drawers), (Table 7). The prevalence of chronic bronchitis increased steeply with age and this was particularly marked among workers over 50 years old (Table 8). Moreover, the prevalence of chronic bronchitis in exposed workers

increased with increasing duration of employment (length of exposure, Table 5).

Further analysis of these results, taking age and duration of exposure into account, showed a significant relationship between the prevalence of chronic bronchitis and duration of exposure in two groups of workers, those aged 20-29 yr, and those over 50 yr. However, this relationship was not statistically significant in the age ranges 30-39 and 40-49 yr. This could be explained by the fact that young people may be highly physically active in the course of their work, which consequently increases lung ventilation. It is known that chronic respiratory disease are more common in old age in those generally exposed to atmospheric pollution, and to industrial pollution in particular.

PULMONARY FUNCTION TESTS

Changes in FEV_{1.0} in exposed workers who did, or who did not, use the bronchodilator at the end of the work shift are shown in Table 9. It is apparent that exposure to a mixture of jute and hemp dust was associated with a statistically significant fall in FEV_{1.0} during the first working day, ($t = 12.5$, $P < 0.001$). This reduction tended to be maintained throughout the week and no further significant decrease was observed during exposure on Thursday. Administration of the bronchodilator after the shift showed that marked reduction in ventilatory capacity was almost fully reversible in all the workers.

Table 8 *Chronic bronchitis according to age group and smoking category in exposed workers*

Smoking category	Number and percentage of workers with chronic bronchitis at ages (yr)			
	20-29	30-39	40-49	50+
Smokers	6 (12%)	9 (21%)	9 (26%)	11 (50%)
Non-smokers	4 (7%)	8 (16%)	7 (14%)	12 (48%)
Smokers and non-smokers	10 (9%)	17 (18%)	16 (26%)	23 (49%)

χ^2 with 3 degrees of freedom = 31.97 for the whole group (smokers and non-smokers); $P < 0.005$.

Table 7 *Chronic bronchitis and atypical chest tightness in exposed workers according to type of work*

Type of work	No. of workers	Total dust (mg/m ³)		Respirable dust (mg/m ³)		Chronic bronchitis		Atypical chest tightness	
		Mean	SD	Mean	SD	No.	%	No.	%
Batting	18	110.23	12.42	30.2	7.8	7	39	1	6
Hackling	72	114.61	13.61	32.6	8.6	29	40	5	7
Carding	139	36.49	6.8	4.9	1.1	22	16	9	6
Drawing	82	3.2	0.9	0.8	0.5	8	10	6	7

χ^2 with 3 degrees of freedom = 26.4 calculated for the prevalence of chronic bronchitis according to the degree of dustiness ($P < 0.005$); for atypical tightness χ^2 was not significant.

Closer analysis of the pulmonary function data showed that smokers and those with bronchitis have greater reductions in forced expiratory volumes at the end of the work shift than do other workers (Table 10). The decrease in FEV_{1.0} was 196 ml in smokers compared with 118 ml in non-smokers. In exposed men with chronic bronchitis the mean decrease in FEV_{1.0} was 236 ml compared with 135 ml in the non-bronchitics. The fall in FEV_{1.0} was not found to be significantly correlated with differences in the type of work (Table 11). Thus it was concluded that there was no correlation between the concentration of dust inhaled and impairment of ventilatory function. Moreover, the changes in FEV_{1.0} with age were not statistically significant (Table 12). On the other hand, changes in FEV_{1.0} according to duration of occupational exposure were significant at the 5% level (Table 13).

Discussion

There is no doubt that exposure to a high concentration of mixed jute and hemp dust represents an occupational health hazard. It caused an acute reduction in ventilatory capacity during the shift,

Table 9 FEV_{1.0} reduction at the end of a work shift in exposed workers compared with controls

Bronchodilator used	Reduction in FEV _{1.0} in ml at end of work shift				
	Exposed workers		Controls		P
	Range	Mean	Range	Mean	
No	40-300	156	0-100	35	<0.001
Yes	0-50	23	0-30	13	>0.1

Table 10 Mean reduction in FEV_{1.0} in exposed workers according to smoking status and presence or absence of chronic bronchitis

Category	No. of workers	Mean reduction in FEV _{1.0} (ml)	P
Smokers	152	196	<0.001
Non-smokers	159	118	
With chronic bronchitis	66	236	<0.001
Without chronic bronchitis	245	135	

Table 11 Mean reduction in FEV_{1.0} at the end of a work shift in relation to dust inhaled because of type of work

Type of work	No. of workers	Mean reduction in FEV _{1.0} at end of work shift (ml)
Batting	18	157
Hackling	72	156
Carding	139	156
Drawing	82	158

Table 12 Mean reduction in FEV_{1.0} at the end of a work shift according to the age ranges of exposed workers

Age range (yr)	No. of workers	Mean reduction in FEV _{1.0} at end of work shift (ml)
20-29	107	153
30-39	92	157
40-49	65	158
50+	47	160

Table 13 Mean reduction in FEV_{1.0} at the end of a work shift according to the period of occupational exposure of the workers

Duration of exposure (yr)	No. of workers	Mean reduction in FEV _{1.0} at end of work shift (ml)
<5	63	143
5-9	91	156
10-14	101	162
15+	56	162

that was considerably more pronounced in those who had chronic bronchitis. Such changes could not be attributed to diurnal variation which, if it occurs, is usually in the opposite direction. Moreover, in the conditions described here, this exposure did not induce typical byssinosis, but did lead to the development of chronic respiratory impairment.

The overall picture of byssinosis in Egypt is still uncertain. Although many investigators, following El Batawi (1962), found a high prevalence of byssinosis in cotton and flax workers, other workers, such as El Sobkey (1975), did not encounter byssinosis in their field studies. The Ministry of Manpower has not registered any byssinotic cases for compensation, apart from one very recent example in Tanta Textile Mill. This can be explained by the fact that the physicians of the Ministry of Manpower and Social Security Organization diagnose byssinosis according to the criteria defined by Taylor and Massoud (1968). All the cases referred were refused compensation because they did not satisfy such criteria. El Batawi (1969) has admitted that, in his previous studies, he found it difficult to fit the cases seen into the classification proposed. This was particularly so in grade ½ and grade 2 where the signs and symptoms actually observed were classified on the assumption that these grades were the nearest possible to the actual findings. He considered that the classification of byssinosis proposed by Roach and Schilling (1960) may not always be applicable except perhaps in British circumstances where there are additional factors involved that may not exist in other countries such as Egypt, India, the United States of America and the Philippines.

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