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A FOLLOW-UP STUDY OF RESPIRATORY FUNCTION IN FLAX WORKERS

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ABSTRACT

A follow-up study of the effect of exposure to flax dust on respiratory function over a three-year period was conducted in 28 female non-smoking workers. The prevalence of byssinosis during the first study (64.3%) was significantly higher than three years later (35.7%) by which time the level of dust exposure was considerably reduced (15.1 to 3.6 mg/m³). The prevalence of other chronic respiratory symptoms was slightly increased in spite of the lower dust exposure. Seventeen workers included only in the first study, i.e. who had left the industry by the time of the second study, had a significantly higher prevalence of all chronic respiratory symptoms than those included in both studies, indicating the effect of selfselection. There was a significant acute fall over the work shift in MEF50% and FEV_1 during both studies ($P < 0.01$), being smaller during the second survey. The mean annual decline of FEV_1 was considerably greater than expected. The reduction of total airborne flax concentration to 3.6 mg/m³ has not decreased the prevalence of grade 2 byssinosis below 4% and has not prevented significant acute reductions of FEV_1 over the work shift.

Exposure to an excessive risk of obstructive lung function loss in textile workers has been described in many papers. However, there have been only few follow-up studies on the chronic respiratory symptoms and lung function changes in textile workers[1,7,8,10]. Studies on the rate of decline of lung function among soft-hemp workers or cotton workers have shown that the rate of decrease is greater than expected (about 25 ml FEV_1/year in a healthy person not exposed to inhalant risks). The effect of cotton or hemp dust exposure on lung function was considered likely to contribute to the accelerated decline of ventilatory function of the lung.

In our three-year follow-up study we investigated ventilatory function changes in a group of female non-smoking flax workers exposed to different concentrations of flax dust.

SUBJECTS AND METHODS

Population

The follow-up study after a three-year period was carried out in a group of 28 female flax workers employed on turbine scutchers. During the first survey a total group of 45 female workers was examined, representing 97% of the total

population employed in the mill. All the workers studied were non-smokers. During the second survey 28 female workers out of 45 examined previously were found still working in the mill.

Working conditions

The flax workers were exposed to airborne dust of biologically retted flax without addition of any chemical substances during the process of retting. During the first survey old machines were in use and, consequently, the airborne dust concentrations were very high (Table 1). At that time there was practically no ventilation system in the plant general or local. Soon after the first survey old machines were replaced by modern equipment with local exhaust systems, which brought about a substantial reduction of the airborne dust concentration in the work environment. General ventilation was also installed. During both studies all machines were located in one large work room.

Respiratory symptoms

Respiratory symptoms were recorded by the standard Medical Research Council questionnaire with additional questions on byssinosis[6].

Definitions

Chronic cough and/or phlegm – cough and/or phlegm production on most days for at least three months each year;

Chronic bronchitis – cough with production of phlegm on most days for a minimum of three months in the year and for not less than two successive years.

Clinical grades of byssinosis

Grade 1/2 – occasional chest tightness or difficulty in breathing at work on Monday;

Grade 1 – chest tightness and/or difficulty in breathing at work on every Monday;

Grade 2 – chest tightness and/or difficulty in breathing during work on Mondays and other working days;

Grade 3 – grade 2 accompanied by evidence of reduced ventilatory capacity.

Dyspnea

Grade 3 – shortness of breath when walking with other people at an ordinary pace on the level;

Grade 4 – shortness of breath when walking at own pace on the level.

Ventilatory function

One-second forced expiratory volume (FEV_1) and the maximum expiratory flow-volume (MEFV) curves were recorded on the first working day of the week before and after the shift. FEV_1 was measured on Bernstein type spirometers and the data were corrected to BTPS. The MEFV curves were recorded on a portable spirometer after Peters, Mead and Van Ganse[5]. Flow rates at 50% of the control vital capacity (MEF50%) were read from the MEFV curves. At least three

measurements were made on each spirometer, and the mean of the two highest recordings was used as the result of the test.

The preshift values of ventilatory capacity were compared with the predicted normal values of CECA[4] for FEV_1 and of Cherniack and Rubber[3] for MEF50%.

Dust measurements

Dust was sampled by Hexhlet two-stage samplers with a horizontal laminal elutriator to determine total and respirable dust concentrations respectively[9]. Dust samples were collected in different sections of the work room.

RESULTS

Dust concentrations

Table 1 shows the dust concentrations measured during both surveys, separately for respirable and total dust. Considerably lower total and respirable dust concentrations were found during the follow-up study.

TABLE 1
Dust concentrations.

Survey		Dust concentrations (mg/m³)	
		Total	Respirable
I	Mean	15.14	5.43
	Range	7.23–22.24	4.32–7.88
II	Mean	3.56	1.80
	Range	0.44–7.95	0.28–2.18

Respiratory symptoms

The prevalence of chronic respiratory symptoms is presented in Table 2. The prevalence of byssinosis in 28 workers, who were included in the follow-up study, was significantly higher in the first (64.3%) than in the follow-up study (35.7%) ($P < 0.05$). Among 18 workers with byssinosis during the first survey,

TABLE 2
Prevalence of chronic respiratory symptoms in flax workers (in %).

N	Survey	Mean age (years)	Mean exposure (years)	Byssinosis	Chronic cough	Chronic phlegm	Chronic bronchitis	Dyspnea grade 3 or 4
28	I	36	12	64.3	39.3	32.1	28.6	21.4
				< 0.05	NS	NS	NS	NS
	II			35.7	53.6	39.3	32.1	28.5
17	I	34	13	82.4	76.5	58.8	52.9	41.1

TABLE 3

Mean changes in MEF50% and in FEV_1 in flax workers. The data are presented as $\bar{X} \pm$ S.D.

N	Survey	MEF50%					FEV_1				
		Before shift (l/sec)	After shift (l/sec)	Difference (l/sec)	Difference (%)	P	Before shift (l)	After shift (l)	Difference (l)	Difference (%)	P
28	I	4.00±1.18 4.79±0.42*	3.24±1.30	−0.76	−19.0	< 0.01	2.70±0.50 3.01±0.41*	2.42±0.55	−0.28	−10.4	< 0.01
	II	3.79±1.12 4.64±0.78*	3.31±1.19	−0.48	−12.7	< 0.01	2.52±0.57 2.96±0.39*	2.32±0.63	−0.20	−7.9	< 0.01
17	I	3.45±1.58 4.77±0.63*	2.87±1.42	−0.58	−16.8	< 0.01 < 0.01	2.59±0.74 3.25±0.59*	2.30±0.70	−0.29	−11.2	< 0.01 < 0.01

*Normal values

TABLE 4

Mean changes in MEF50% and FEV_1 in female flax workers according to the byssinosis symptoms. The data are presented as $\bar{X} \pm$ S.D.

Group	Survey	MEF50%					FEV_1				
		Before shift (l/sec)	After shift (l/sec)	Difference (l/sec)	Difference (%)	P	Before shift (l)	After shift (l)	Difference (l)	Difference (%)	P
With byssinosis in the first and in the second survey N = 10	I	3.71±1.02 4.76*	3.00±1.31	−0.71	−19.1	< 0.05	2.80±0.54 3.15*	2.47±0.54	−0.33	−11.8	< 0.01
	II	3.51±0.97 4.70*	3.12±1.07	−0.39	−11.1	< 0.01	2.69±0.60 3.09*	2.57±0.57	−0.12	−4.5	< 0.01
Without byssinosis in the first and in the second survey N = 8	I	4.30±1.43 5.02*	3.46±1.54	−0.84	−19.5	< 0.05	2.59±0.25 3.00*	2.41±0.32	−0.18	−6.9	< 0.05
	II	4.04±1.31 4.82*	3.46±1.34	−0.58	−14.3	< 0.01	2.32±0.34 2.94*	2.03±0.43	−0.29	−12.5	< 0.01

*Normal values

grade B 1/2 was found in 11.1%, grade B 1 in 44. 4% and grade B 2 in 44.4% of workers. In ten workers out of 18, who still had byssinosis symptoms during the follow-up study grade B 1/2 was found in 20%, grade B 1 in 20%, and grade B 2 in 60% of workers. There was no significant difference in the prevalence of other chronic respiratory symptoms during the two studies.

By analysing the data for the group of 17 workers who had been included in the first study only (Table 2), i.e. who had left the industry by the time of the follow-up study, there was a higher prevalence of all chronic respiratory symptoms (byssinosis: 82.4%; chronic cough: 76.5%; chronic phlegm: 58.8%; chronic bronchitis: 52.9%; dyspnea: 41.4%) compared with the simultaneous prevalence in 28 workers included in the follow-up study (64.3%; 39.3%; 32.1%; 28.6%; 21.4%). Among workers with byssinosis who were included in the first study only, 14.3% had byssinosis grade B 1/2, 28.6% grade B 1, 42.9% grade B 2, and 14.3% grade B 3.

Ventilatory function

Data on ventilatory capacity are shown in Table 3. Statistically significant acute reductions over the work shift were recorded for MEF50% and FEV_1 in 28 workers both in the first and the second survey ($P < 0.01$). Acute reductions were greater in the first than in the second study but the difference was not statistically significant. The relative acute reductions in MEF50% were larger than in FEV_1. Comparison of preshift MEF50% and FEV_1 in flax workers with expected normal values[3,4] revealed significantly lower values in flax workers in both surveys (MEF50%: $P < 0.01$; FEV_1: $P < 0.05$). Among 28 workers, eight (28.6%) had preshift FEV_1 less than 80% of expected values during both studies.

Table 3 also shows the mean acute changes in ventilatory capacity in 17 flax workers seen in the first survey only, i.e. who had left the industry by the time of the follow-up study. These workers showed a statistically significant acute decrease of MEF50% and FEV_1 ($P < 0.01$) similar to those recorded at the same time in 28 workers included in the follow-up study. The preshift values of MEF50% and FEV_1 in 17 workers were significantly lower than expected normal values ($P < 0.01$). Five workers out of 17 (29.4%) had preshift FEV_1 less than 80% of expected normal values.

The data on ventilatory capacity in workers with byssinosis during both studies and in those without byssinosis during both studies are presented in Table 4. The relative acute reductions in the flow rates in the second study were considerably smaller than those in the first except for FEV_1 in workers without byssinosis. This group of eight workers shows also a great annual fall of preshift FEV_1.

DISCUSSION

The results obtained in this study appear to support the preliminary approach of the British Occupational Hygiene Society Sub-Committee on Vegetable Textile Dusts (in preparation) which is just considering a Hygiene Standard for flax dust. Even with very considerable control of environmental dust some risk to health remains as long as there is airborne flax dust in the work

environment. Although, having introduced effective engineering measures of control and, particularly, having provided scutchers and combs with local exhaust ventilation, we succeeded in reducing the average exposure level in the work environment from 15.1 to 3.6 mg/m³ total dust, the prevalence of all the recorded chronic respiratory symptoms did not fall with the exception of that of byssinosis which dropped from 64.3 to 35.7%. Byssinosis prevalence of all grades was still high; the positive health effect of dust reduction was much more pronounced in the reduction of grade 2 byssinosis which was reduced from 28.6% to 7.1%. This is very similar to the results obtained by Carey and co-workers[2] in their survey of flax workers in Northern Ireland who found the byssinosis prevalence of all grades to be 30% and of grade 25.5% at a mean total flax dust concentration 2.7 mg/m³.

Even after the reduction of the flax dust level to 3.6 mg/m³ the mean acute fall of FEV_1 over the work shift was 0.20 l or about 8%, and that of MEF50% was almost 13%, indicating a definite acute effect of flax dust exposure.

The fact that the mean annual fall of FEV_1 was 60 ml, almost three times the normal average annual decline of healthy Yugoslav women of the corresponding age, in spite of the reduction of the exposure level practically immediately after the first survey, suggests that the airborne flax concentration remained too high.

From the results obtained in the study a conclusion can be drawn that with the reduction of the airborne dust level of biologically retted flax to 3.6 mg/m³ the criterion put forward by the British Occupational Hygiene Society Sub-Committee on Vegetable Textile Dusts will not be met: the prevalence of grade 2 byssinosis above 4% is not likely to be prevented neither will the mean fall of FEV_1 over the work shift be maintained below 200 ml.

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