
Study of lung function changes among different grades of byssinosis

Y. M. EL-SADIK, M. MOSELHI, A. R. EL-HINADY, and M. N. MOSTAFA
High Institute of Public Health and Faculty of Medicine, Alexandria University, U.A.R.

El-Sadik, Y. M., Moselhi, M., El-Hinady, A. R., and Mostafa, M. N. (1972). *Brit. J. industr. Med.*, **29**, 184-187. Study of lung function changes among different grades of byssinosis. This study comprised 80 workers of whom 50 are byssinotics, 15 are chronic asthmatic bronchitics, and 15 are free of chest symptoms.

A comparison of the changes in forced expiratory volume in one second due to exposure in the first working day in the week among them (80 workers) showed a greater reduction in byssinotics than among the others. Reduced maximum expiratory flow rates were found only in byssinotics. Independent of exposure, only third-grade byssinotic cases (22 out of 50) showed changes in predicted vital capacity, residual volume, total lung capacity, three seconds per cent vital capacity, total vital capacity timed in seconds, and air velocity index.

The pattern of changes in these lung functions is mostly obstructive; only two cases showed the pattern of restrictive disease.

This study denotes that two types of changes in pulmonary functions occur due to byssinosis. The first type is a temporary change in pulmonary functions which occurs only on exposure to the aetiological factor (cotton or flax dust). This type occurs among all grades of the disease. The nature of this type is obstructive. The second type of change is permanent. This type occurs only among the third grade of the disease and is not dependent on immediate exposure. This type of change is mostly obstructive but may show some restriction.

Exposure to cotton dust is associated with a fall in the ventilatory capacity during the work shift (McKerrow, McDermott, Gilson, and Schilling, 1958). El Batawi, Schilling, Valić, and Walford (1964) mentioned that in workers suffering from byssinosis this fall is marked.

Forced expiratory volume in one second ($FEV_{1.0}$) decreases significantly during the shift in workers with a history of byssinosis, and such reduction increases according to the severity of the disease (Valić *et al.*, 1968).

Others mentioned that $FEV_{1.0}$ is lower among byssinotics than normals (Lammers *et al.*, 1964). Vital capacity (VC) was used for determination of the specific reduction changes occurring in byssinotic cases, and the results obtained were similar to that

for $FEV_{1.0}$ (McKerrow *et al.*, 1958; Žuškin and Valić 1966; Valić *et al.*, 1968). McKerrow and his associates (1958) showed an increase in airway resistance among grade 1 and 2 byssinotic cases.

The aim of this study is to compare the changes in some of the above-mentioned lung functions among different byssinotic grades, chronic asthmatic bronchitics, and symptom-free individuals during shift exposure, and to study other lung functions among the byssinotics independent of their exposure.

Material and method

The study included 15 chronic asthmatic bronchitics, 15 symptom-free workers, and 50 byssinotics who were diagnosed according to the Roach and Schilling (1960) questionnaire with certain modifications in accordance

with our culture and background experience of this disease. All workers (80) were from the cardrooms of a cotton textile plant. A chest radiograph was done on all cases to exclude any with findings that could not be explained by his present diagnosis. For each of the 80 individuals, FEV_{1.0} and maximum expiratory flow rate (MEFR) were measured before and after the end of the first shift on the first working day in the week using a McKesson Vitalor Model VC-25. Each individual was trained to use the apparatus. Five readings were recorded for each individual. The first two readings were considered as an assurance of familiarity of the individual with the apparatus. The mean for such measurements was obtained from the last three readings. Any case showing a difference of more than 10% between the last three recorded readings led us to repeat the procedure.

Independent of exposure the following lung function tests were measured only for byssinotics (50). Residual volume (RV) was obtained using a Godart Nitrograph apparatus with the open circuit method. Timed vital capacity was obtained by timing the vital capacity expired as rapidly as possible on the revolving kymograph at its fastest speed (2 mm/sec) using a 9 litres Lode D-51 spiograph equipped with an oxygen bell for volume stabilization. From RV and VC the total lung capacity (TLC) was calculated. Predicted values for VC and TLC were obtained using the equation given by Baldwin, Courmand, and Richards (1948). The predicted values were adjusted for height and age, and they were based on U.S. Veterans as there are no published figures for Arabs. U.S. Veteran values were accepted by us as they are similar to those of normal Egyptians shown in a pilot unpublished study. Air velocity index (AVI) was obtained from Gaensler's (1950) equation.

About 30 minutes' rest was given for each individual before he was subjected to the measurement of the previously mentioned pulmonary functions, and also each individual was trained to use the apparatus before the beginning of each test. Lung functions were measured while the worker was seated. Each measurement was repeated three times. All lung volumes were expressed at body temperature under the prevailing barometric pressure saturated with water vapour (BTPS).

Results and discussion

The results are shown in Tables 1 to 4.

Table 1 shows the changes in FEV_{1.0} and MEFR

for different grades of byssinosis, chronic asthmatic bronchitis, and those free of symptoms due to the morning shift exposure (7 a.m. to 3 p.m.) in the first working day in the week. All the byssinotic cases showed a reduction in FEV_{1.0}. This reduction ranged from a mean of 22% among the first-grade cases (12), to 31% among the third-grade cases (22). Second-grade cases (16) showed a mean reduction of 24%.

The change in FEV_{1.0} among the chronic asthmatic bronchitics (15) and the symptom-free individuals (15) was a reduction of 3% for each. So one can say that exposure to cotton dust leads to a drop in FEV_{1.0}; this does not exceed 5% in those free of symptoms or in chronic asthmatic bronchitics. The drop is greater among byssinotics and this increases with the progress of the disease. This agrees with the findings of Valić and others (1968).

The change in MEFR among byssinotics was a reduction varying from 25 to 30%. There was no change in MEFR among symptom-free individuals or those suffering from chronic asthmatic bronchitis. These two lung tests can be used to confirm the diagnosis of byssinosis.

Table 2 shows the percent of predicted VC, RV, TLC and percent of residual volume to total lung capacity among different grades of byssinosis. These values do not differ from the normal among first-grade and second-grade byssinotic cases. Only the third-grade byssinotic cases showed a significant difference from normal, a reduction in VC and TLC and an increase in RV and in the ratio of the residual volume to the total lung capacity.

Table 3 shows the first second and 3 seconds percent VC and total VC among the byssinotic cases.

Significant changes in these measurements are present among third-grade byssinotics (22 cases). These changes are a reduction in first second percent of VC and 3 seconds percent of VC and an increase in the time of the total VC.

Table 4 shows the AVI among different grades of byssinosis. The AVI differs significantly from normal only among third-grade cases. These had an AVI of less than one. Tables 2, 3, and 4 show that first- and

TABLE 1

CHANGES IN FEV_{1.0} AND MEFR BEFORE AND AFTER THE SHIFT AMONG DIFFERENT GRADES OF BYSSINOSIS, CHRONIC ASTHMATIC BRONCHITICS, AND SYMPTOM-FREE SUBJECTS

Diagnosis	No.	FEV _{1.0}			MEFR (l.)		
		Before	After	%reduction	Before	After	%reduction
First-grade byssinosis	12	3.1	2.4	22	397	298	25
Second-grade byssinosis	16	3.0	2.3	24	372	275	26
Third-grade byssinosis	22	1.5	1.04	31	181	127	30
Chronic asthmatic bronchitis	15	1.97	1.90	3	215	214	0
Symptom-free	15	2.20	3.10	3	446	445	0

TABLE 2
PERCENT OF PREDICTED VC, RV, TLC AND PERCENT OF RV TO TLC AMONG DIFFERENT GRADES OF BYSSINOSIS

Grade of byssinosis	No.	% predicted VC			% predicted RV			% predicted TLC			RV/TLC% ¹		
		Mean	S.D.	t	Mean	S.D.	t	Mean	S.D.	t	Mean	S.D.	t
First ..	12	102	4.7	+ 1 (N.S.)	102	10.3	+ 0.7 (N.S.)	102	5.7	+ 1.2 (N.S.)	26	3.2	+ 1.1 (N.S.)
Second ..	16	102	7.8	+ 1 (N.S.)	104	9.9	+ 1.6 (N.S.)	102	4.3	+ 1.9 (N.S.)	26	3.2	+ 1.25 (N.S.)
Third ..	22	81	7.9	- 11.3 (S)	141	55	+ 3.5 (S)	95	12.3	- 2 (N.S.)	34	9.6	+ 4.4 (S)

¹Normal = 25 (Comeroe, 1951)
N.S. = not significant at 1% level
S = significant.

TABLE 3
FIRST AND 3 SECONDS PERCENT VC AND TOTAL VC TIME (SECONDS) AMONG DIFFERENT GRADES OF BYSSINOSIS

Grade of byssinosis	No.	First second % of VC ¹			3 seconds % of VC ²			Total VC time ³		
		Mean	S.D.	t	Mean	S.D.	t	Mean	S.D.	t
First ..	12	78	10.1	- 1.73 (N.S.)	98	2.8	+ 1.25 (N.S.)	3.4	0.8	—
Second ..	16	78	8.3	- 2.4 (N.S.)	96	4.2	- 1 (N.S.)	3.8	1.2	—
Third ..	22	52	15	- 9.7 (S)	79	15	- 5.6 (S)	7	1.7	+ 6.5 (S)

¹Normal = 83% (Gaensler, 1950)
²Normal = 97% (Gaensler, 1950)
³Normal = 4 sec (Gaensler, 1950)
N.S. = not significant at 1% level
S = significant at 1% level

TABLE 4
AIR VELOCITY INDEX AMONG DIFFERENT GRADES OF BYSSINOSIS

Grade of byssinosis	No.	Air velocity index ¹		
		Mean	S.D.	t
First	12	0.99	0.1	- 0.33 (N.S.)
Second	16	0.98	0.1	- 0.8 (N.S.)
Third	22	0.69	0.19	- 7.7 (S)

¹Normal = 1 (Gaensler, 1950)
N.S. = not significant at 1% level
S = significant at 1% level

second-grade byssinotics do not suffer from permanent effects on lung function. Third-grade cases suffer from permanent effects independent of exposure. All the lung function changes denote an obstructive element. This obstructive element may be due to an increase in airway resistance or to a reduction in lung elasticity.

Owing to the high standard deviation in RV among the third-grade byssinotic cases (Table 2) we tried to classify these cases according to the degree of change in RV, TLC, AVI, first second percent VC and total-time VC. According to this classification eight of the 22 third-grade byssinotic cases had a mean percent predicted RV of 201 (range 135-260), mean percent RV to TLC of 44 (range 29-52), mean first second percent VC of 41 (range 28-54), mean total VC of 10 seconds (range 7-13), and mean AVI

of 0.48 (range 0.34-0.68); this pattern of lung function denotes severe obstruction. Three cases had a mean percent predicted RV of 128 (118-136), mean percent RV to TLC of 31 (range 28-35), mean first second percent VC of 50 (range 89-601), mean total-time VC of 6 seconds (range 5-7), and mean AVI of 0.69 (range 0.64-0.73); this lung function pattern denotes mild obstruction. Two cases had a mean percent predicted RV of 86 (range 79-92), mean percent RV to TLC of 23 (range 22-24), first second percent VC for each of 78, mean total-time VC of 4.5 seconds (range 3-6), and mean AVI of 0.97 (range 0.93-1.0); this pattern of lung function shows the liability of restrictive element. The remaining nine cases show values for lung functions which denote both obstructive and restrictive elements.

This study shows that two types of changes in pulmonary functions occur due to byssinosis. The first is a temporary change in pulmonary functions which occurs only on exposure to the aetiological factor (cotton or flax dust). This type is seen among all grades of the disease and is of an obstructive nature.

The second type of change is permanent. This type occurs only among third-grade byssinotics and it does not depend on exposure. This type of change is mostly of an obstructive nature but it may also be restrictive.

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