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SHORT COMMUNICATION

RESPIRATORY EFFECTS OF OCCUPATIONAL EXPOSURE TO ASBESTOS

MASOUD-SHERIF R. MUKHTAR AND GUTTI MADAN MOHAN RAO*

Department of Physiology,
Faculty of Medicine,
The Great Al-Fateh University of Medical Sciences,
Tripoli, Libya

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Abstract : Ventilatory capacities of 73 Libyan men working in the Asbestos-Cement Pipe factory in Jenzur, a residential area near Tripoli, Libya and those of 73 age-matched healthy Libyan men unexposed to asbestos were determined. The mean values of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1) for men unexposed to asbestos were 3.89 ± 0.084 and 3.64 ± 0.082 liters respectively. The respective values for men exposed to asbestos were 3.62 ± 0.082 and 3.29 ± 0.097 liters. Thus, there has been a significant decrease in the ventilatory function of the men exposed to asbestos as compared with age-matched unexposed counterparts.

Duration of exposure is an important factor in the onset of pulmonary dysfunction as indicated by decreased vital capacity.

Key words : ventilatory capacity; forced vital capacity; peak expiratory flow rate; smoking; maximum ventilatory volume; asbestos

INTRODUCTION

The excessive use of asbestos in the early part of this century had created a health hazard not only to the occupationally exposed persons, but also to the general public (1).

Epidemiologic studies conducted worldwide have established that all forms of asbestos have a capacity to cause asbestosis, lung cancer, mesothelioma and a variety of other forms of cancer. These studies have shown that the incidence of these diseases is quantitatively related to the cumulative exposure to asbestos in a positive dose-relationship (2).

Studies have been made on the health effects of asbestosis in miners (3), steel mill and glass bottle manufacturing plant workers (4), textile workers (5), railroad workers (6), sheet metal workers (7), construction workers (8), insulation workers (9) and workers in petrochemical factory (10).

Asbestos inhalation produces pulmonary fibrosis which is probably dose-related (11). It was shown that among the asbestos insulation workers, a group known to have a high incidence of bronchogenic carcinoma were cigarette smokers. Pulmonary fibrosis was diagnosed when fine linear densities more prominent than normal bronchovascular markings were judged to be present in the pulmonary parenchyma especially in the peripheral third of the lung fields in roentgenograms (12).

This investigation was undertaken to assess the effect of exposure to asbestos on the ventilatory capacity of workers in Asbestos-Cement-Pipe factory in Jenzur near Tripoli, Libya.

*Corresponding Author and present address : 21 Second Main Road, Ramakrishna Nagar, Madras - 600 057

METHODS

The Asbestos-Cement-Pipe factory is located in Jenzur about 20 km from Tripoli. There are 73 workers all male in this factory. They comprised the main study group. The factory has no information regarding the dust composition of the ambient air in the factory premises.

Seventythree age-matched Libyan men not exposed to asbestos were selected as control subjects. The exposed and unexposed subjects were separately divided into four age-groups : 21-30, 31-40, 41-50 and 51-60 years.

Immediately before the lung function test, a questionnaire was filled out during an interview with the subject. The date of birth, standing height (stature), sitting height and body weight of each subject were recorded. The lung function measurements were made with Volugraph 2000 (Mijnhardt, Holland) with the attached Spimitest 2000D. The latter gives a printout of the respiratory measurements of the subject : forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), maximum ventilatory volume (MVV), peak expiratory flow rate (PEFR), 75%, 50% and 25% of maximum expiratory flow (MEF 75%, MEF 50% and MEF 25%). The values are automatically expressed in BTPS units. The flow volume curve for each subject was printed out. Measurements were made in the sitting posture using a nose-clip. Each test was performed at least three times and the best performance was always selected. Between the tests, a minimum of 1 minute rest was allowed.

The number of cigarettes smoked per day was noted for the exposed as well as the unexposed subjects. The age-matched subjects selected were also smoking the same number of cigarettes per day as the exposed workers (± 1 cigarette).

Mean, standard deviation and standard error of each variable were calculated. Regression analyses and student 't' tests were performed. P-value less than 0.05 was taken to indicate statistical significance.

RESULTS

Fig. 1 shows the linear relationship between age and FVC, FEV_1, MVV and PEFR with the

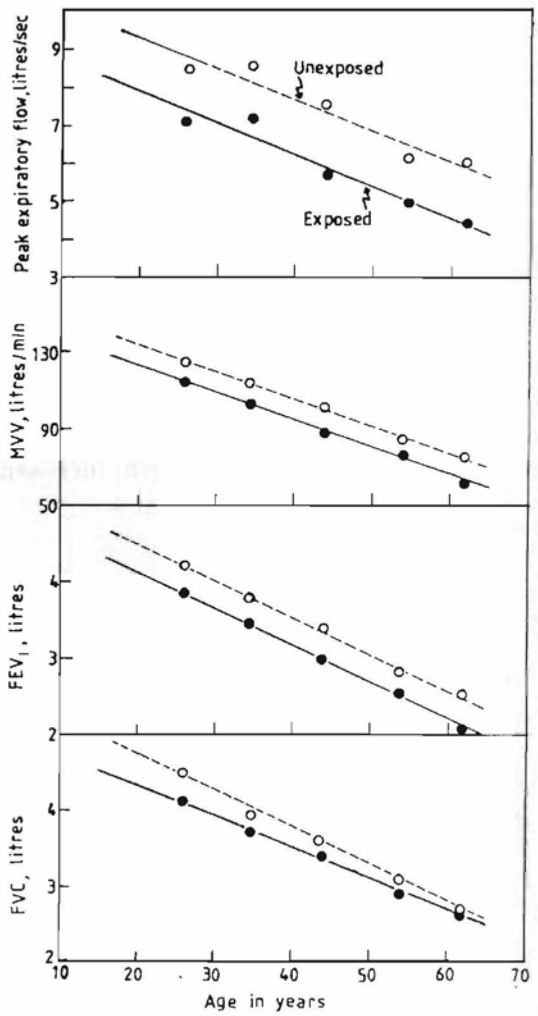

Fig. 1 : The linear relationship between age and FVC/FEV_1/MVV/PEFR in subjects exposed to asbestos and in age-matched unexposed subjects.

Unexposed subjects :

Age-FVC_1; Y=5.8-0.05X; r=0.99; P<0.001
Age-FEV_1; Y=5.4-0.047X; r=0.99; P<0.001
Age-MVV; Y=162.8-1.43X; r=0.99; P<0.001
Age-PEFR; Y=11.0-0.8X; r=0.99; P<0.001

Exposed subjects :

Age-FVC; Y=5.1-0.04X; r=0.99; P<0.001
Age-FEV_1; Y=5.0-0.048X; r=0.99; P<0.001
Age-MVV; Y=153-1.43X; r=0.99; P<0.001
Age-PEFR; Y=9.56-0.83X; r=0.99; P<0.001

TABLE I : Mean values (±SEM) of FVC, FEV_1, MVV, MMF, PEFR, $MEF_{75\%}$, $MEF_{50\%}$ and $MEF_{25\%}$ of the subjects exposed to asbestos (n=73) and the age-matched unexposed subjects (n=73) with percent difference.

Parameter	*Unexposed*	*Exposed*	*% decrease*	*Statistical significance of decrease*
FVC (1)	3.89 ± 0.084	3.62 ± 0.082	6.96	P<0.025
FEV_1(1)	3.64 ± 0.082	3.29 ± 0.097	9.32	P<0.005
MVV (1/min)	108.74 ± 2.455	98.56 ± 2.928	9.36	P<0.001
MMF (1)	4.93 ± 0.193	4.26 ± 0.181	13.47	P<0.01
PEFR (1/sec)	7.86 ± 0.270	6.42 ± 0.301	18.27	P<0.001
$MEF_{75\%}$ (1)	7.24 ± 0.258	6.03 ± 0.302	16.62	P<0.0025
$MEF_{50\%}$ (1)	5.40 ± 0.220	4.70 ± 0.207	12.74	P<0.01
$MEF_{25\%}$ (1)	2.91 ± 0.129	2.59 ± 0.125	10.74	P<0.05

respective regression equations. The respiratory parameters show a decrease with increasing age. Table I shows the percent decrease in respiratory parameters in the exposed subjects as compared with their unexposed counterparts with the statistical significance of the difference.

The flow-volume curves for different age groups of exposed and unexposed subjects are presented in Fig. 2. The relationship between years of exposure to asbestos and the values of FVC, FEV_1, MVV and PEFR is shown in Fig. 3. The duration of exposure to asbestos has an effect on the ventilatory capacity of the exposed workers.

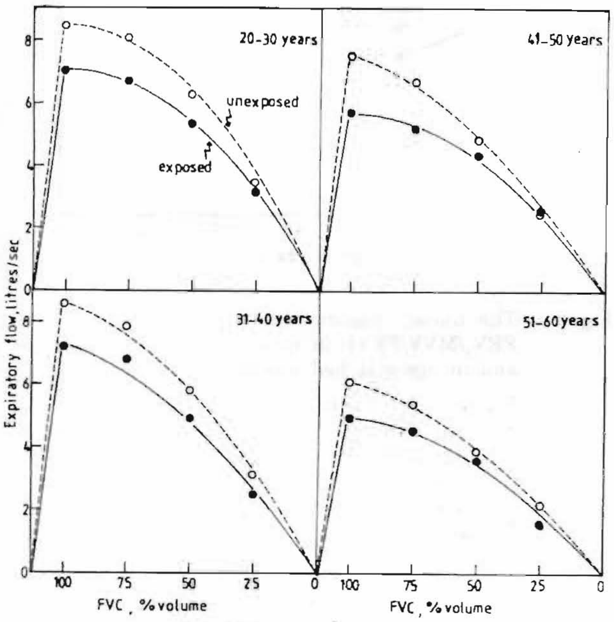

Fig. 2 : Expiratory flow-volume curves of exposed and unexposed subjects of different age groups.

In our study group, 46% of the exposed subjects are smokers with an average of 20.2±1.65 cigarettes per day, while in the age-matched unexposed group 45.6 smokers with an average of 20.6±1.8 cigarettes per day.

DISCUSSION

Several studies have established the levels of asbestos burden in the lungs of occupationally exposed persons (13) and some investigators have assessed the parenchymal concentrations in cohorts from general populations (14, 15). The measurement of particulate burden in the lung reflects the dust which has escaped the respiratory clearance mechanisms. These mechanisms efficiently clean the lung of inhaled debris. For example, these mechanisms are credited with eliminating as much as 90% of the inhaled dust in coal workers (16). While most clearance from the parenchyma occurs via muco-ciliary transport, passage of tracers into the lymphatics was shown in animal models (17, 18). The pulmonary lymphatic and circulatory systems can provide potential routes for relocation of inhaled particulates in man.

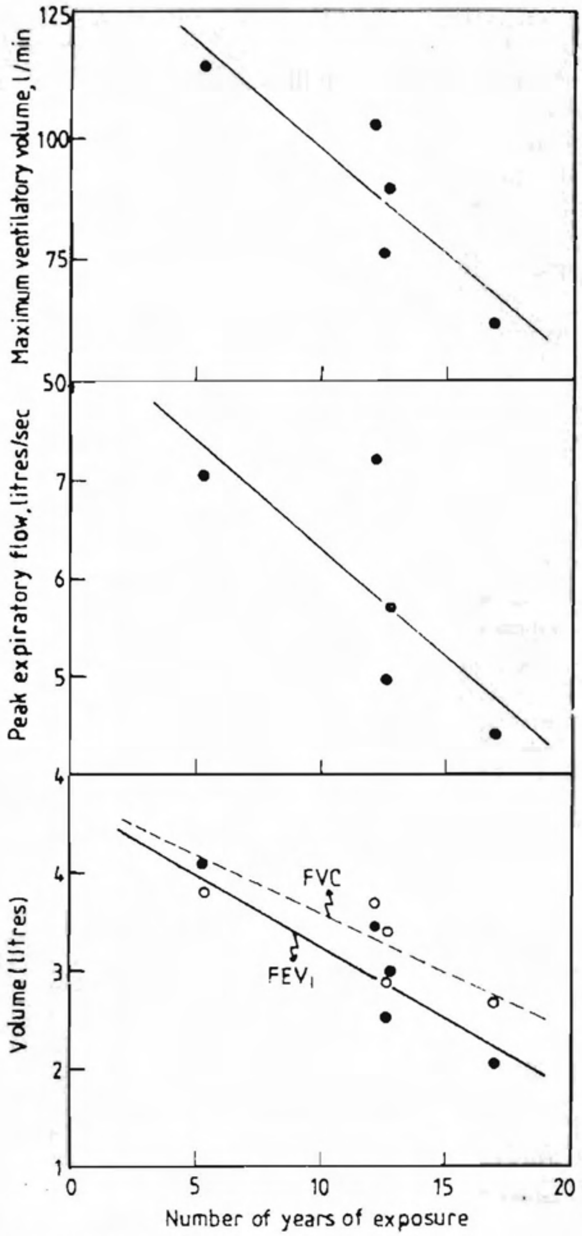

Fig. 3 : Effect of years of exposure to asbestos on respiratory function values.

Year of exposure-FVC: Y=4.8-0.12X; r=0.87; P<0.05

Years of exposure-FEV_1: Y=4.7-0.147X; r=0.88; P<0.05

Years of exposure-MVV; Y=142-4.4X; r=0.88; P<0.05

Years of exposure-PEFR: Y=8.6-0.22X; r=0.74; P<0.05

Occupational exposure to asbestos results in various functional disorders of the lung as reflected in decreased vital capacity. It was shown that pleural fibrosis is a significant variable negatively affecting forced vital capacity. This, when extensive has a negative restrictive effect on the pulmonary function. Both circumscribed plaques and diffuse pleural thickening were reported to be independently associated with decrements in forced vital capacity (19).

In the present investigation, there has been a statistically significant decrease in all parameters of pulmonary function in the subjects exposed to asbestos as compared with their unexposed counterparts. The duration of exposure to asbestos is an important factor in the decrease of ventilatory function as illustrated in Fig. 3.

Several workers have shown the effect of smoking on the ventilatory capacity. Chatterji et al (20) have investigated spirometric lung function in 334 male non-smokers and 300 healthy male smokers of the age group 20-60 years. They reported that FVC, FEV_1, MVV and PEFR deteriorated with age in both groups and that the decrease was greater in smokers. Kilburn and Warshaw (10) and Weiss (12) have reported that the effects of asbestos on FVC are greater in smokers than in non-smokers. Thus, the factors that affect the respiratory parameters are : age, smoking and duration of exposure to asbestos. Multiple regression analyses indicate that these factors affect the lung function independently. In the present study, the decrease in ventilatory capacity in exposed workers is due to exposure to asbestos because an attempt has been made to eliminate to an extent the other two confounding factors viz., age and smoking.

It would have been helpful in the evaluation of the effect of asbestos exposure on lung function if the diffusion studies are made and the x-rays are obtained. Arterial PO_2, PCO_2 and pH levels at rest and during exercise would have further enhanced the accuracy of the diagnosis of diffusion defects. Any how, the present investigation allows us to conclude that exposure to asbestos results in lowered vital capacity.

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