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EFFECT OF AMMONIA, UREA AND DIAMMONIUM PHOSPHATE (DAP) ON LUNG FUNCTIONS IN FERTILIZER PLANT WORKERS

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Abstract : A spirometric study (FVC, FEV_1 & PEFR/Min) was carried out in workers exposed to fertilizer chemicals (91) as a whole, out of which 31 were Ammonia, 30 Urea and 30 DAP plant workers, and 68 were controls belonging to the same age, sex, body surface area and socio-economic status.

This study showed asignificant reduction in both PEFR/min and FEV_1, the reduction being more in PEFR /Min., seems to indicate obstructive type of lung changes affecting the larger air-ways first, followed by bronchospasm. But FVC showed a significant reduction only after more than 10 years of exposure, probably causing restrictive changes only after prolonged exposure.

Out of the 3 chemicals, DAP affected all the 3 parameters most, followed by Ammonia and Urea affected the least.

Key words : lung function tests FVC FEV_1 PEFR/Min ammonia urea DAP fertilizer workers

INTRODUCTION

Pneumoconiosis is virtually always related to the occupation of the afflicted person. They are preventable if detacted early. The major challenge that faces today's Physician is the detectioin of dust-induced physiological impairment early in the course of the disease (1).

Lung fuction study is considered as one of the earliest tools in the detection of Pneumoconiosis-induced diseases. Reduction in ventilatory functions is reported in cotton mill workers (2,3), coal miners (4) and grain elevators. (5). A significant drop in FVC and FEV_1 was exhibited in workers exposed to grain and flour dust (6). Even the inhalation of volatile gases like SO_2 can cause pathological changes, including laryngotracheal and pulmonary oedema, eventually death (7,8) in excessive concentrations. Whereas long-term effects (4 years) show obstructive type of changes in spirometric findings (9). Various agents such as Ozone, SO_2 and Tobacco smoke seem to cause hyper-reactivity (10), increase in permeability of pulmonary mucosa (11) and damage to the pulmonary epithelium after exposure (12), which affect lung functions.

The present study has been carried out in workers exposed to irritants like Ammonia, Urea and Diammonium Phosphate (DAP) in Fertilizer plants to find out whether there is any change in lung function tests prior to the onset of diseases.

METHODS

This study was carried out at the Mangalore Fertilizer Chemical Plant, Mangalore. The Selected Fertilizer workers were exposed to various chemical irritants, who apparently were in good health. Accordingly, 91 workers underwent lung function tests, out of which 31 were working in the Ammonia plant,

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30 in the urea plant and 30 in the Diammonium phosphate plant. In each of these subjects their age, sex, height, weight and duration of expousre to chemical irritants were recorded. A group of 68 people having comparable body surface area chosen from the same socio-economic status and sex served as controls. The smokers were excluded to avoid the effect of smoking on lung function.

The lung function study was carried out using Morgans Spirocheck portable spirometer. The parameters studied were FVC, FEV_1 and PEFR/Min. All the tests were performed in the standing posture. Each subject was asked to exhale into the spirometer as forcibly as possible after maximum inspiration. Each test was repeated 3 times and the highest reading was taken for calculation. Statistical significance was calculated by using paired 't' test.

RESULTS

The parameters studied FVC, FEV_1 and PEFR/min were compared between controls and fertilizer chemical workers as a whole and also between controls and urea, ammonia and DAP plant workers individually. The subjects were regrouped according to their duration of exposure into 2 groups: (1) upto 10 years of exposure (51) and (2) more than 10 years of exposure (40) and compared with controls.

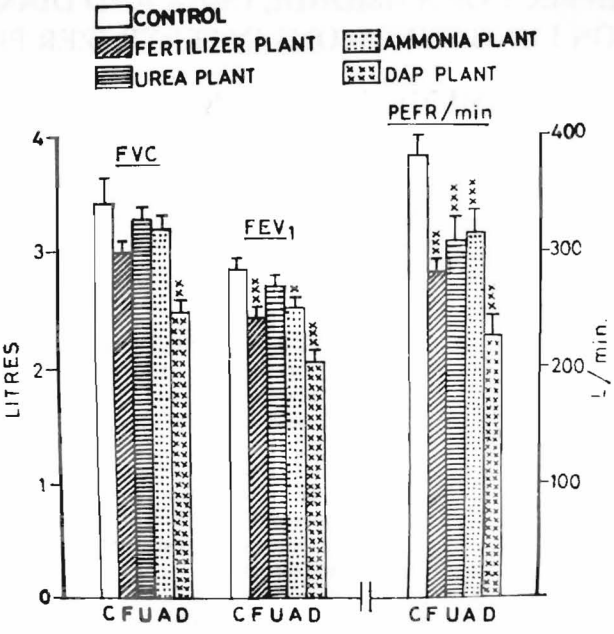

Fig. 1 : Comparison of FVC, FEV_1 and PEFR/min in fertilizer chemical plant, urea plant, ammonia plant and DAP plant workers with controls

*P < 0.05; **P<0.01; ***P < 0.001

The FVC showed only a significant reduction (P<0.05) in Fertilizer plant workers as a whole (91) when compared to controls (68), where as FEV_1 and PEFR/min showed a highly singificant reduction (P<0.001).

TABLE I : Comparison of lung function in fertilizer chemicals, DAP urea and ammonia plant workers with controls.

Parameters used in litres	*Controls* (n=68)	*Fertilizer chemicals* (n=91)	*DAP plant* (n=30)	*Urea plant* (n=30)	*Ammonia plant* (n=31)
FVC	3.43±0.21	3.00±0.06*	2.51±0.06**	3.28±0.11	3.19±0.07
FEV_1	2.84±0.10	2.43±0.06***	2.08±0.08***	2.68±0.10	2.52±0.1*
PEFR/Min	383.3±7.6	282.±11.6***	227.6±18.2***	306.9±18.8***	314±19.9***

*P<0.05 ; **P<0.01 ; ***P<0.001

Fig. 1 shows compartison of FVC, FEV_1 and PEFR/ Min between controls and workers of fertilizer plant as a whole, urea ammonia and DAP plant workers individually.

The urea plant workers when compared with controls showed significant reduction (P<0.001) only in PEFR/Min. Their FVC and FEV_1 did not show any significant change.

The ammonia plant workers when compared with controls did not show any significant fall in FVC, but their FEV1 (P<0.05) and PEFR/min (P<0.001) showed a significant fall.

On the other hand, the DAP workers showed significant reduction in their FVC (P< 0.01), FEV_1 and PEFR/ min (P<0.001) when compared to controls.

TABLE II : Comparison of lung fuctions in fertilizer chemical workers with controls according to the duration of exposure

(Data are mean±SE)

Parameters used (in litres)	*Controls (n = 68)*	*Duration of exposure to chemicals*	
		Upto 10 Years (n = 51)	*More than 10 years (n = 40)*
FVC	3.43±O..21	2.98±0.07	2.76±0.09*
FEV_1	2.84±0.10	2.55±0.08*	2.29±0.07***
PEFR/Min	383.3±7.6	298±17.4***	265±14.3***

*P < 0.05, **P < 0.01, ***P < 0.001.

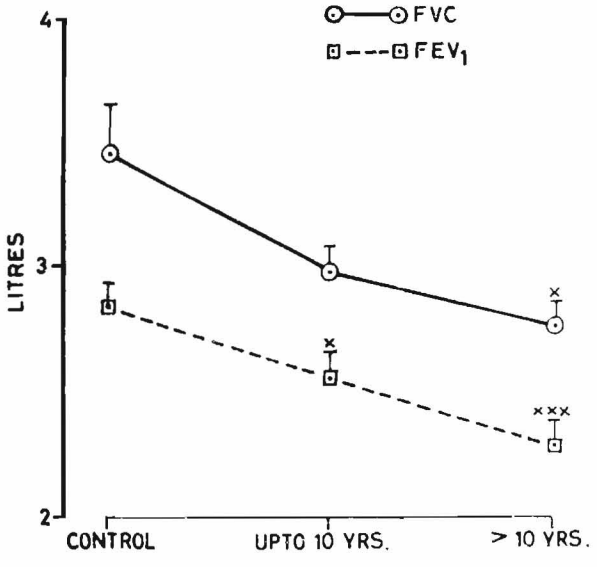

Fig. 2 : Comparison of FVC & FEV_1 in fertilizer chemical workers with controls according to the duration of exposure.

*P < 0.05, **P<0.01; ***P < 0.001

Fig. 2 shows the comparison of FVC and FEV_1 between controls and fertilizer plant workers as a whole according to the duration of exposure. FVC showed a significant fall (P<0.05) in upto 10 years of exposure group which fell further (P< 0.001) after more than 10 years of exposure.

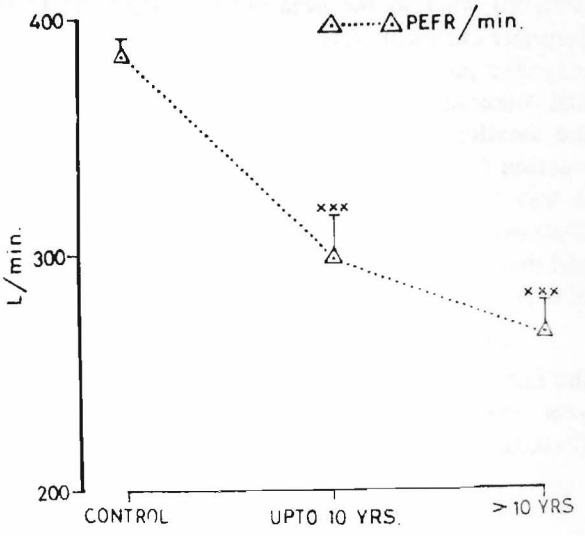

Fig. 3 : Comparison of PEFR/min in fertilizer chemical workers with that of control according to the duration of exposure.

*P < 0.05; **P<0.01; ***P < 0.001

PEFR/min was very much decreased (P<0.001) in upto 10 years of exposure group, which reduced further in more than 10 years of exposure group.

DISCUSSION

Among the lung function tests, the exposure to Fertilizer chemicals affect firstly and mostly PEFR/ min. The PEFR/min was highly reduced even in upto 10 years of exposure group. Further the PEFR/min was significantly reduced in workers exposed to all the types of chemicals, urea, ammonia and DAP. This shows that all the fertilizer chemicals affect larger airways immediately. It has been shown that exposure to cotton dust affects larger airways which was evident from their reduced PEFR/min (3). It was further proved by the pathological study of Byssinosis in which they had detected abnormalities in larger airways with low PEFR/min (13). So the reduction in PEFR/min in this study may indicate that fertilizer chemicals may primarily cause abnormalities in larger airways first.

The FEV_1 though reduced by the fertilizer chemicals upto 10 years of exposure (P<05), the

decrease in FEV_1 when compared to PEFR/min ($P<0.001$) was less. Among the chemicals the DAP decreased FEV_1 ($P<0.001$) much more than Ammonia ($P<0.05$) whereas the urea did not affect the FEV_1. Fertilizer chemicals further decreased FEV_1 ($P<0.001$) only after more than 10 years of expousre. This shows that Ammonia and DAP being more volatile can enter the smaller bronchiloles and cause hypersensitive reaction (10,11,12) leading to bronchospasm. Further it was shown that these changes occur slowly and continuously and that is why FEV_1 was affected slowly and then further deteriorated after more than 10 years of exposure.

Whereas FVC was not affected significantly in the fertilizer worker untill exposed for more than 10 years ($P<0.05$), Only DAP reduced FVC significantly ($P<0.01$), showing that restrictive changes are caused by DAP.

In conclusion, it is evident that fertilizer chemicals affect the pulmonary larger airway function first, followed by bronchospasm thus predominently causing obstructive type of lung disorders. They also affect the pulmonary alveoli only after longer exposure to cause restrictive type of lung disorders.

Among the three fertilizer chemicals, DAP affects all the 3 parameters of lung functions causing both obstructive and restrictive changes in the lungs, followed by ammonia and urea affects them the least.

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