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VENTILATORY AND DIFFUSION STUDIES IN SMOKER AND NON SMOKER FLOUR-MILL WORKERS

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Abstract : Various pulmonary function tests, FVC, FEV_1/FVC %, PEFR, EFR_{25-75}, MVV and Tlco were measured in 25 asymptomatic male flour mill workers and 50 healthy subjects not working at flour mill, to assess the effect of flour dust on lungs. All the subjects of different groups were well matched in their anthropometeric parameters and socio economic status. In smoker flour mill workers signilcant reduction was present in both ventilatory and diffusion functions of lungs, which was more pronounced in subjects who consumed larger quantity of tobacco and were exposed to flour dust for longer duration. On the other hand deterioration of pulmonary functions in non smoker flour mill workers was found to be statistically not significant. The relative strength of both the parameters viz tobacco and flour dust for impairment of pulmonary functions is discussed for being a pointer to further studies.

Key words : pulmonary function tests flour dust transfer lung factor

INTRODUCTION

It is well known that industrial dust inhalation over a long period leads to proliferative and fibrotic changes in lungs (1). Significance of pulmonary functions in assessing responses to various air borne pollutents, has been known since middle of the 20th century and large number of studies have been undertaken to assess the effect of dust on lung functions in various occupations. Reduction in ventilatory functions is reported in cotton workers (2, 3), coal miner (4) and grain elevators (5). Recently diffusing capacity for carbon monoxide is found to be decreased in asbestos workers (6), coalminers (7) begasse workers (8) and bauxite workers (9). Wheat flour is the main item of food consumed in the form of 'chapatis' in North India. Mostly wheat flour is made available in the market in bulk from flour mills. Some people like to purchase and store wheat for few months. Then they get it cleaned, washed and like to get the grinding done at a small scale only. To meet this demand, a large number of small scale flour mills (chakkis) are functioning in villages, towns and cities. Though a large number of persons are likely to be employed at a flour mill, it is observed that only one or at the most two persons work at a chakki at a time and are exposed to flour dust during their working time. Mostly they work for 3-5 hours each morning and evening. So far not much is known about effects of flour dust on pulmonary functions. Only few cases of asthma and rhinitis have been reported in flour mill workers (10-12). Diffusion capacity was found to be decreased in backers who were having allergy to flour (13).

In order to assess the effects of environmental pollution by flour dust, pulmonary functions, both ventilatory and diffusion, have been studied in

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smoker and nonsmoker persons working at these small scale flour mills (chakkis). So far authors are not aware of any study on this subject reported in in literature in India or from abroad.

METHODS

The present study was carried out on 25 asymptomatic, healthy male subjects, 19-50 years of age, with at least 2 years exposure to flour dust at small scale flour mill (Chakki). 17 of them were smokers (S) and 8 non smokers (NS). As most of chakki workers were smokers, 25 smoker and 25 non smoker healthy subjects (not exposed to flour dust) of similar age, height, weight and socioeconomic status were taken as control. All the subjects were clinically and radiologically free from any cardio-respiratory disease or any other disease which could hinder with performance of test.

Detailed history of working, in terms of daily working hours and period of service as chakki worker was recorded. History of smoking was taken with special references to type of smoking, number of biris and cigarettes smoked per day and duration of smoking.

Subjects were asked to abstain from smoking for at least 2 hours before reporting in the laboratory. Each subject was explained about the method of the test, to eliminate the fear and apprehension. He was instructed to keep glottis open during the study. All the tests were performed in resting state with subject sitting on the stool, between 9 AM to 11 AM, at least one hours after light breakfast. Morgan Transfer Test Model 'C' and Computor Magn '88' (PK Morgan, Chathan, Kent UK) were used to study and analyse the different parameters viz Forced vital capacity (FVC), Forced expiratory volume first second percentage of FVC($FEV_1/FVC\%$), Peak expiratory flow rate (PEFR), Expiratory flow rate 25-75% of FVC (FER_{25-75}), Maximum voluntary ventilation (MVV) and Transfer lung factor for carbon monoxide (Tlco). Tlco was measured using single breath technique (Tlco Sb) as described by Cotes (14). After a forceful expiration, subject made maximal inspiration (from residual volume) of gas mixture containing 0.27% CO, 14.27%. He, 20.0% O_2 and balance N_2. He held his breath for a period of 9-10 seconds for proper exchange of gases to take place and then exhaled forcefully. After discarding first 900 ml of gases coming from respiratory passages, expired alveolar gas was collected in a PVC bag of rotary Valve box, of same apparatus, dried and made CO_2 free by passing through calcium chloride and soda lime granules. Then it was analysed by infrared carbon monoxide analyzer, helium Katharometer and paramagnetic oxygen analyzer of transfer Test Model 'C', Haemoglobin of each subject was measured and entered in calculation of Tlco by Computer Magna 88, Correction for back pressure of CO was also applied.

RESULTS

Anthropometeric data of all the subjects, viz Chakki workers and control (smokers, non smokers), were well matched to each other in age, height and weight.

As 60% of the smokers were bidi smokers so the cigarette smokers were also converted into bidi smokers by taking into consideration the amount of tobacco consumed by them (1 bidi = 200 mg., 1 cigarette=1000 mg.). Total amount of tobaco consumed by the subject was expressed in terms of Bidi Pack Years (15). Bidi Pack Year=No. of packs (10 bidi) smoked/day × No. of years of Smoking.

Period of smoking in Chakki workers ranged from 1-28 years (mean 12.64) while in controls (smoker group) it ranged from 2-24 years (mean 11.32). Smoker and nonsmoker chakki workers were exposed to flour dust for 10.29 ± 6.62 years and 7.24 ± 5.42 years respectively. Pulmonary

TABLE I : Pulmonary functions in workers and controls.

Column	*1*	*2*	*3*	*4*	*5*
			Statistical Analysis		
Parameter	*Worker*	*Control*	*Worker/Control*	*Control Smoker/Non S*	*Worker Smoker/Non S*
n	25(S+Non S)	50(S+Non S)	(25/50)	(25/25)	(17/8)
FVC(L)	3.88±0.58	3.97±0.12	↓ NS	↓ NS	↓ NS
$FEV_1/FVC(\%)$	81.92±6.63	84. 9±6.41	↓ NS	↓ NS	↓ NS
PEFR(L Sec)	6.63±2.04	7.51±1.79	↓ <0.05	↓ NS	↓ <.01
EFF_{25-75}(L/Sec)	3.34±1.17	3.76±1.11	↓ NS	↓ NS	↓ NS
MVV(L/min)	120. 3±32.96	144. 5±27.37	↓ <.01	↓ <.05	↓ <.01
Tlco (ml/min/mmHg)	27.54±6.08	30.49±4.13	↓ <.05	↓ NS	↓ <.01
Effective factor			Flour dust	Smoking	Smoking

Values are Mean±SD, Worker—Chakki worker, Control—Healthy control, Non S—Non Smoker, S—Smoker
↓ NS—Reduction but not significant ↓ —Significant reduction

TABLE II : Effect of Floor dust and Smoking on Pulmonary functions.

Column	*6*	*7*	*8*		
Parameter	*Nonsmoker Worker/Control*	*Smoker Worker/Control*	*Smoker Worker*	*Vs*	*Nonsmoker Control*
n	(8/25)	(17/25)			(17/25)
FVC(L)	↓ NS	↓ NS			↓ NS
FEV_1/FVC (%)	↓ NS	↓ NS			↓ <.05
PEFR(L/Sec)	↓ NS	↓ <.05			↓ <.001
FER_{25-75}(L/Sec)	↓ NS	↓ NS			↓ <.05
MVV(L/min)	↓ NS	↓ <.01			↓ <.001
Tlco (ml/min/mmHg)	↓ NS	↓ <.05			↓ <.001
Effective factor	Flour dust	Flour dust	Smoking+Flour dust		

Worker—Chakki worker, Control—Healthy control, ↓ NS—Reduction but not significant, →—Significant reduction

function tests of chakki workers (NS+S) and control (NS+S) are given in Table I. Data was analysed statistically using student 't' test to compare functions of workers (NS+S) Vs control (NS+S), smoker control Vs Non smoker control, smoker worker Vs Nonsmoker worker (Table I). Nonsmoker workers and smokers were compared separately to respective control (Table II).

In order to assess the contribution of flour dust in causation of detrioration of pulmonary functions, the data was subjected to study correlation coefficient (r) and multiple correlation coefficient (R) by taking age of smoker/nonsmoker, pack year of smoking, working years (duration of exposure to flour dust in years) as independent parameters and FVC, PEFR, MVV, Tlco as dependent parameters, (Table III).

TABLE III : Correlation Coefficient (r) and Multiple Correlation Coefficient (R) in Chakki workers.

	Smoker n=17				*Nonsmoker n=8*	
Correlation with	*FVC*	*PEFR*	*MVV*	*Tlco*	*MVV*	*Tlco*
Age only (r)	−.5112	−.1732	−.4685	−.5090	−.6186	−.5038
	<.05	NS	NS	<.05	<.01	<.05
Age+Pack Year (R)	.5552	.2621	.5211	.5632		
	<.05	NS	<.05	<.02		
Age+Pack year	.5581	.3817	.5213	.5789	.6239	.5098
+working years (R)	<.02	NS	<.05	<.02	<.01	<.05

Pack year for smokers only.

DISCUSSION

Pulmonary functions were studied in 75 male subjects, comprising of chakki and nonchakki (control) workers. Persons who had worked for at least two or more years at chakki were included the study. The parameters viz PEFR, MVV, Tlco were reduced in Chakki workers (NS+S) as compared to controls (NS+S) (Col. 3 Table II) indicating that exposure to flour dust is affecting their lungs. As most of the chakki workers were smokers (68% smokers and 32% non smoker) and it is well documented in literature that tobacco smoking adversely affects pulmonary functions, (16-19), the data obtained was analysed, separately into smoker and non smoker groups as well.

As is evident from table II, the reduction in pulmonary functions is of a greater severity in smoker workers (Col. 5) than smoker control (Col. 4) when compared with non smoker workers and non smoker controls respectively. Table II shows that pulmonary functions of smoker Chakki workers (Col. 7) are affected to a greater extent than non smoker chakki workers (Col. 6). In comparison to non smoker controls, smokers workers show significant reduction in almost all parameters (Col. 8). It is suggestive of that pulmonary functions of smoker Chakki workers must have been influenced by flour dust as well in addition to tobacco smoking.

Study of correlation coefficient (r) and multiple correlation coefficient (R) showed that effeet of age in smoker Chakki workers on FVC, PEFR, MVV and Tlco is accentuated with addition of pack years of smoking and still further on addition of period of service (working years) at Chakki (Table III). Hence indicating that pulmonary functions show better correlation when age, pack year and duration of exposure to flour dust are all taken together. On the other hand non smoker chakki workers are exposed to only flour dust, (and not to tobacco smoking) their pulmonary functions show only non significant effect of flour dust (Table III).

Extension of study in non smokers who have worked at Chakki for a longer duration will be more confirmative, though from the present study it can be concluded that smoking habit of Chakki workers acts as a primary factor to which flour dust may contribute further for deterioration to their pulmonary function.

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