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Original Research Article

Effect of Chronic Flour Dust Exposure on Pulmonary Functions of Flour Mill Workers

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ABSTRACT

The development of our country has brought many changes that include rapid civilization and industrialization. A large rural population is relocating to the urban areas in the search for livelihood and is involved in various types of indoor and outdoor jobs. Indoor air pollution is a major consequence of modernization, causing health problems in developing countries.
Flour milling is a rampant industry in our country where the workers are continuously exposed to dust. Several clinical syndromes have been attributed to grain dust exposure, which may reflect the complex composition of grain dust. Workers engaged in flour milling are at risk of developing impaired lung function due to high level of dust exposure. Our aim was to correlate the lung function abnormalities with the duration of exposure to dust. 50 non-smoking male flour mill workers exposed to flour dust for more than 3 years were selected for our study. They were divided into three groups depending on the duration of exposure. Forced expiratory spirograms were recorded by RMS medspiror. Parameters such as forced vital capacity (FVC), forced expiratory volume in 1st second (FEV1), the ratio of FEV1/FVC, forced expiratory flow in the middle half of FVC (FEF25-75%), peak expiratory flow rate (PEFR) and maximum voluntary ventilation (MVV) were assessed. The results were analyzed by using the ANOVA test. There was a negative correlation between duration of exposure and pulmonary function parameters like FVC, FEV_1, FEV_1/FVC, PEFR and MVV which was statistically significant. $FEF_{25-75\%}$ also went on decreasing with increasing duration of exposure but was statistically not significant.

Keywords: Flour mill workers, Flour dust, Pulmonary functions, Spirometer

INTRODUCTION

The workplace environment affects the health of individuals. People working in dusty environment face the risk of inhaling particulate materials that may lead to adverse respiratory effects. [1] Spirometry plays a significant role in the assessment of extent of lung dysfunction and describes the effects of restriction or obstruction on the lung function. [2]

The twentieth century has seen an increasing recognition of lung diseases that can be caused by exposure to harmful substances in the workplace. [3] Dust particles which are inhaled and lodged in the lungs irritate and set up an inflammatory reaction. Healing of this inflammation causes fibrosis leading to defective oxygen diffusion and impaired lung function. [4]

The respiratory tract is readily accessible to noxious factors in the environment. The vulnerability of the respiratory system is increased by the large volume of air readily contaminated by dust that moves in and out of the lungs. [5] The health effects produced by particulate matter is a function of particle size. [6]

A threshold value of 0.5 $mg/m^3$of flour dust was proposed as the occupational exposure level (OEL) in the breathing zone of workers by the American conference of government industrial hygienists (ACGIH). The ACGIH defines flour as a complex organic dust consisting of wheat, rye, millet, barley, oats, corn meal, or a combination of these, which have been ground or processed by milling. It may contain a large number of contaminants including silica, fungi with their metabolites (aflatoxin), bacterial endotoxins, insects, mites, mammalian debris and various chemical additives such as pesticides and herbicides. [7]

With great advances in pulmonary physiology and medical instrumentation that have occurred during the recent years, pulmonary function testing has come to assume a central place in the practice of pulmonary medicine. [8] Pulmonary function tests permit accurate reproducible assessment of the functional state of the respiratory system and allow quantification of the severity of disease, thereby enabling early detection as well as assessment of the natural history and response to therapy. [9]

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, J.J.M Medical College, Davangere during the year 2012 after obtaining clearance from ethical committee.

This study was undertaken to observe the effects of increased duration of exposure to flour dust on the pulmonary functions of adult male workers of age group 25-50 years. Fifty workers from Laxmi flour mill in Davangere city who were involved in flour milling for more than three years were taken as study group. The study group was further classified into three groups depending on years of exposure. The study groups were matched for age, height, weight and Body Mass Index [BMI].

Inclusion and exclusion criteria:-

50 non-smoking male workers of age between 25 to 50 years with history of more than 3 years of flour dust exposure without any past or present history of pulmonary or systemic diseases formed the study group. This group was further divided into subgroups depending on the duration of exposure. These workers worked for at least 8 to 10 hours per day without using any protective measures.

Females and subjects with gross abnormalities of vertebral column or thoracic cage, person with known history of neuromuscular disease, malignancy, bronchial asthma, bronchiectasis and pulmonary tuberculosis, those who have undergone major abdominal or chest surgery were excluded.

The study groups were selected as per inclusion and exclusion criteria. Written and informed consent was taken after explaining the procedure with its significance in their vernacular language. A pre tested structured Performa was used to collect the relevant information. A detailed history was taken and a clinical examination of all the systems was done to exclude medical problems. Patient information chart was prepared giving a separate identification number for each subject. BMI was calculated from the Height (mt) and weight (kg) of the subjects. Spirometry was performed by using computerized spirometer [RMS Medspiror]. This spirometer has a mouth piece attached to a transducer assembly which is connected to an adaptor box connected to the computer by a serial cable. Software from Recorders and Medicare system is loaded onto the computer. This software allows the calculation of the predicted values for age, sex, weight and height and it also gives the recorded values of all the parameters.

Procedure was explained and demonstrated to the subjects before they actually took up the maneuver. They were also encouraged to practice the maneuver before commencing it. The test was performed with the subject in sitting position and was repeated three times with adequate rest. The test with the best maneuver was selected. The machine gave the comparison of various parameters between the three maneuvers and the best among the three was accepted. Then the subject was asked to perform the slow vital capacity test. He was asked to breathe normally followed by a deep inspiration and a deep expiration, again continuing with normal breathing.

MVV was assessed by asking the subject to inhale and exhale as rapidly and deeply as possible for a period of 15 seconds.

The results for each parameter were compared between the study groups and were statistically analyzed.

RESULTS

The results were presented according to the duration of exposure in the flour mills.[3-5,6-10,11-17 years]. Out of 50 flourmill workers, 10 workers were in the age group of 25-30 years, 14 were in 31-35 years, 7 were in 36-40 years, 4 in 41-45 years and 15 in 46-50 years age group. [Table 1]

TABLE 1: Age wise distribution of flour mill workers

Age in years	Flour mill workers (n)
25 – 30	10
31-35	14
36-40	7
41-45	4
46-50	15
Total	50

Comparison of pulmonary function parameters with relation to duration of exposure to dust in the flour mill workers.

FVC:

The percentage predicted of FVC (%) in flourmill workers with duration of exposure of 3-5 years was 78.4 ± 10.3, this value was 72.4 ± 10.2 in the workers whose duration of exposure was 6-10 years. In workers exposed for more than 11 years (11-17 years), FVC was 68.1 ± 9.0. It was observed that the level of FVC decreased with increase in the duration of exposure. There was statistically significant decrease in the level of FVC with increase in the duration of exposure to flour dust ($p< 0.05$). (Table 3)

TABLE 2: Basic characteristics of subjects

Basic characteristics	Flour mill workers (n = 50)	Significance	
		t-value	p-level
Age in years	38.8 ± 8.1	1.68	0.10
Height (cm)	160.4 ± 6.4	0.90	0.37
Weight (kg)	59.72 ± 6.26	0.60	0.55
BSA (sqm)	1.62 ± 0.09	1.35	0.18
BMI (kg/m^2)	23.33 ± 3.05	0.65	0.52

All values are expressed as Mean ± SD

TABLE 3: Comparison of pulmonary function parameters with relation to duration of exposure to flour dust

Duration of exposure (yrs)	n	FVC (% pred)	FEV1 (% Pred)	FEV_1/FVC (% pred)	$FEF_{25-75\%}$ (% Pred)	PEFR (% pred)	MVV (% Pred)
3 – 5	14	78.4 ±10.3	74.6±11.4	106.9±12.3	107.6±28.9	81.4±21.4	87.1 ±14.0
6-10	13	72.4 ±10.2	64.8±12.1	97.0 ±19.4	96.2 ±27.0	66.0±17.5	78.0 ±11.2
11-17	23	68.1 ±9.0	61.6 ±9.4	86.8 ±10.4	82.7±29.4	65.2±17.9	71.0 ±16.9
One way ANOVA	F	4.95	6.47	9.41	2.63	3.58	4.75
	P	< 0.05*	< 0.01*	<0.001**	0.08	< 0.05*	< 0.05*

All values expressed as Mean ± SD (* is significant, ** is highly significant)

FEV_1:

The percentage predicted of FEV_1 (%) in flour mill workers with duration of exposure of 3-5 years was 74.6 ± 11.4. This value was 64.8 ± 12.1 in workers exposed for 6-10 years. In workers exposed for more than 11 years (11-17 years), FEV_1 was 61.6 ± 9.4. It was observed that the level of FEV_1 decreased with increase in duration of exposure to flour dust. There was statistically significant decrease in the level of FEV_1 with duration of exposure of more than 11 years. (11-17 years) ($p< 0.01$). (Table 3)

Ratio of FEV_1 / FVC:

The percentage predicted of FEV_1/FVC in workers exposed to flour dust for 3-5 years was 106.9 ± 12.3. This value was 97.0 ± 19.4 in workers exposed for 6-10 years. In those who were working for more than 11 years (11-17 years), FEV_1/FVC was 86.8 ± 10.4. It was observed that the level of FEV_1/FVC decreased with increase in duration of exposure. The decrease in FEV_1/FVC with duration of exposure was statistically significant ($p < 0.001$). (Table 3)

$FEF_{25-75\%}$:

The percentage predicted value of $FEF_{25-75\%}$ in workers exposed to flour dust for 3-5 years was 107.6 ± 28.9. This value was 96.2 ± 27 in those exposed for 6-10 years. In those who were working for more than 11 years (11-17 years), it was found to be 82.7 ± 29.4. It was observed that the level of $FEF_{25-75\%}$ decreased with increase in duration of occupational exposure, but the decrease was not statistically significant ($p > 0.05$). (Table 3)

PEFR:

The percentage predicted of PEFR in the flour mill workers who were exposed to dust for 3-5 years was 81.4 ± 21.4. This value was 66.0 ± 17.5 in workers exposed for 6-10 years. In those working for more than 11 years (11-17 years), the PEFR was found to be 65.2 ± 17.9. It was observed that the level of PEFR decreased with increase in the duration of exposure. There was statistical significant decrease in the level of PEFR with increase in duration of dust exposure ($p < 0.05$). (Table 3)

MVV:

The percentage predicted of MVV in the flour mill workers who were exposed to dust for 3-5 years with 87.1 ± 14. This value was 78 ± 11.2 in those exposed for 6-10 years. In those working for more than 11 years (11-17 years), the MVV was found to be 71 ± 16.9. It was observed that the level of MVV decreased with increase in the duration of exposure. There was statistical significant decrease in the level of MVV with increase in the duration of dust exposure ($p < 0.05$). (Table 3)

DISCUSSION

Flour is a complex organic dust consisting of wheat, rye, millet, oats, corn or a combination of these, which have been processed or ground by milling. Flour dust consists of particles ranging from as small as 1 μm to greater than 20 μm in size. It causes symptoms throughout the respiratory tract, ranging from rhinitis in the nasal area to chronic bronchitis and asthma in the lungs.

Human lungs react in a variety of ways to retained dust particles, over a trivial aggregation of cells at one end of the scale to striking and often progressive collagenous fibrosis or widespread, but resolvable cell accumulations or granulomas at the other. The dusts themselves cause little damage to the lung parenchyma and the pathological result depends largely on the inflammatory and fibrotic responses to the particular dust. [10]

Once deposited in the respiratory tract, the fate of a particle depends on the body's immune clearance mechanisms and on its ability to resist them. The alveoli have no cilia and particles that deposit there are engulfed by large wandering cells called macrophages. The foreign material is then removed from the lung via the lymphatics or the blood flow. [11]

Though the developed countries are very careful about occupational health, it is quite neglected in developing countries like India. Flour mills produce a huge amount of dust. On an average, flour mill workers are exposed to the workplace environment for 8-10 hours a day and there are no provisions for minimization of the dust produced in the flour mills in our country. Poor ventilation is a basic problem in flour mills which leads to accumulation of the dust. Cumulative exposure to dust results in chronic pulmonary diseases. Spirometry is one of the easy tools to detect lung function abnormalities at an early stage so that preventive measures can be adapted before irreversible changes set in. [12]

Several clinical syndromes have been attributed to grain dust exposure, which may reflect the complex composition of grain dust. Workers exposed to flour dust during milling, mixing and transfer operations tend to develop respiratory disease. [13] When airborne dusts are inhaled, scavenger cells like macrophages try to dissolve the dust particle, but if the dust is tremendous, scavenger cells fail to dissolve it. They lodge in and irritate the lungs setting up an inflammation which on healing results in fibrosis. [14]

Chen (1992) classified the flourmill workers into heavy and light exposure group to conclude that FEV1, FVC, PEFR were significantly lower in the heavily exposed group. This implies that heavy concentration of dust over a long period impairs lung function to a significant level. [15] Zodpey and Tiwari (1998) measured the PEFR and found that it was reduced in flour mill workers as compared to controls, decline was significantly associated with duration of exposure. [16] Corzo and Naveda studied lung functions in wheat processing plant workers and reported a decrease in PEFR, FEV%, FEF 25-75%. They also showed a significant deterioration with increase in duration of exposure. [17]

In our study the results showed that the workers with less than 5years exposure did not have much impairment in lung function. The workers exposed for 6-10 years showed reduction in lung function and above 10 years showed a further reduction in pulmonary function.

This study was undertaken to study the effect of increased duration of exposure of flour dust on the lung functions of workers by classifying the workers according to the duration of exposure and analyzing the results. There was a negative correlation between duration of exposure and pulmonary function parameters like FVC, FEV_1, FEV_1/FVC, PEFR and MVV which was statistically significant. $FEF_{25-75\%}$ also went on decreasing with increasing duration of exposure but it was statistically not significant. Though our study was by no means exhaustive, it does provide a glimpse about the effects of flour dust on the pulmonary functions. Moreover, the nature of this industry is unorganized and it is scattered all over the country sporadically. Hence no comprehensive occupational health package is available for the health care and welfare of these workers. Educational materials and information can be made available to employees as a part of the right to know legal requirements in the state. The employer can organize or direct the safety committee to address the issue in meetings.

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