



EFFECT OF FLOUR DUST EXPOSURE ON PULMONARY FUNCTION OF FLOUR MILL WORKERS USING SPIROMETRY

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ABSTRACT

Background: Chronic dust exposure at the workplace adversely affects the airways resulting in lung function impairment. There is a dose-response relationship as lung function shows a decline with increasing exposure duration.

Objectives: The study was conducted to determine the effect of flour dust exposure on the ventilator function of flour mill workers and its association with the duration of exposure. **Results:** There was a statistically significant reduction in FVC ($p=0.003$), FEV_1 ($p=0.002$), PEFR ($p<0.001$), $FEF_{25-75\%}$ ($p<0.001$) and $FEV_1/FVC\%$ ($p<0.001$) values of flour mill workers compared to controls. All the parameters depicted progressive reduction in mean values with increasing exposure duration. However, no significant difference was observed between the lung function of flour mill workers with exposure duration of up to 5 years and the control group. **Conclusion:** Prolonged exposure to flour dust has a significant impact on the lung function of the workers and is associated with exposure duration. Periodic health surveillance may play an important tool in safeguarding the health of flour mill workers.

KEYWORDS : Flour dust, spirometry, duration of exposure, lung function

INTRODUCTION

Occupational lung diseases are common sequelae of chronic dust exposure among industrial workers. Dust related lung diseases are of the multifactorial origin of which, type of dust, the concentration of dust, size of dust particles, period of exposure and genetic factors play a major role.^{1,2} Besides dust, the health of workers is also affected by the unfavourable environment in form of excessive noise and insufficient light.

Flour dust is complex organic dust with varied compositions, including particles of husk, pollen, starch grains, pesticides, insects, mites, bacteria, fungi and spores.³ Tiny flour dust particles produced at various stages of processing such as crushing, grinding, milling, packaging, etc, and of size ranging from 0.5 to 3 micron are deposited in the lungs.⁴ Lungs are affected due to sensitization and chronic allergic response of the respiratory tract to flour dust over a long period of exposure.⁵

Spirometry is a simple non-invasive method of assessing lung function. Spirometry is used to assess the extent of lung dysfunction and to classify it as obstructive in which resistance to airflow is increased due to partial or complete blockage or restrictive lung disease in which lung expansion is reduced resulting in decreased lung capacity.⁶ Early recognition followed by appropriate treatment of occupational lung disease can significantly reduce both morbidity and mortality among exposed workers.⁷

The present study was designed to assess the lung function of flour mill workers and compare it with that of non-smoker non-exposed healthy controls and assess any variation in pulmonary function status depending on the duration of exposure in the industry.

METHODS

This case-control study was conducted among 50 male flour mill workers of Mullana and surrounding areas in the age group of 25-50 years with more than 3 years of exposure to flour dust were included in the study. 50 age-matched controls from the general population with no history of smoking or conditions that may affect lung function were selected for the study.

After recording a detailed history, clinical examination was conducted on subjects and height and weight were recorded. Pulmonary function tests were conducted through a computerized spirometer, Spiro-Excel (Medicaid Systems Chandigarh). The parameters recorded were, Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), Peak Expiratory Flow Rate, Forced Expiratory Flow Rate ($FEF_{25-75\%}$), FEV_1/FVC ratio and Respiratory Rate.

Ethical consideration

Informed and written consent of all the participants was taken before

conducting the study. Approval of the ethics committee of the institution was also sorted.

Statistical Analysis

All the observations of the study were recorded as per the proforma attached and statistically analysed by the SPSS version 20 computer program. Mean \pm SD (standard deviation) was calculated and an independent sample T-test was used to obtain statistical significance (p-value) between the exposed and non-exposed groups. A p-value of less than 0.05 was considered significant in intergroup comparison.

RESULTS

The baseline characteristics of the study and control groups were comparable as no statistically significant differences were observed in their mean age in years (Controls, 36.0 ± 13.3 ; Subjects, 33.2 ± 7.0 ; p value= 0.189), weight in kgs (Controls, 66.8 ± 11.4 ; Subjects, 63.9 ± 5.3 ; p value= 0.100), and height in cms (Controls, 170.5 ± 8.4 ; Subjects, 168.3 ± 5.0 ; p value= 0.116). We observed a statistically significant reduction in FVC ($p=0.003$), FEV_1 ($p=0.002$), PEFR ($p<0.001$), $FEF_{25-75\%}$ ($p<0.001$) and $FEV_1/FVC\%$ ($p<0.001$) values of flour mill workers compared to controls. (Table 1)

Table 1: Pulmonary function test parameters among study and control groups

Parameters (Mean \pm SD)	Controls (n=50)	Study group (n=50)	t value	p value
FVC	3.61 ± 0.46	3.31 ± 0.52	3.019	0.003
FEV_1	3.25 ± 0.41	2.84 ± 0.81	3.155	0.002
PEFR	7.69 ± 0.47	5.9 ± 1.79	6.826	<0.001
$FEF_{25-75\%}$	4.05 ± 0.39	2.97 ± 0.99	7.179	<0.001
$FEV_1/FVC\%$	90.05 ± 1.79	82.99 ± 11.73	4.209	<0.001

Duration of flour dust exposure also had a significant effect on the lung function of the flour mill workers. There was a significant progressive reduction in the mean values of all the lung function test parameters with an increase in the duration of exposure to flour dust. (Table 2)

Table 2: Effect of flour dust exposure duration on pulmonary function test parameters

	Duration of exposure in the study group			F value	p-value
	<5 years (n=21)	6 - 10 years (n=20)	>10 years (n=9)		
FVC	3.5 ± 0.42	3.3 ± 0.58	2.89 ± 0.38	5.171	0.009
FEV_1	3.17 ± 0.78	2.78 ± 0.74	2.21 ± 0.66	5.367	0.008
PEFR	7.2 ± 1.49	5.4 ± 1.2	3.98 ± 1.27	20.329	<0.001
$FEF_{25-75\%}$	3.8 ± 0.74	2.46 ± 0.62	2.17 ± 0.7	26.895	<0.001

FEV ₁ /FVC%	88.69 ± 6.45	80.58 ± 11.76	75.01 ± 15.44	5.999	0.005
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Comparison of pulmonary function of flour mill workers having exposure duration of up to 5 years with the control group did not reveal any significant difference. However, we observed a significant difference in all lung function test parameters of flour mill workers with exposure duration of 6 – 10 years and more than 10 years when compared to the control group. (Table 3)

Table 3: Comparison of pulmonary function of exposure duration groups with the control group

	Duration of exposure in the study group		
	<5 years (n=21)	6 - 10 years (n=20)	>10 years (n=9)
FVC			
t value	0.907	2.335	4.452
p value	0.368	0.022	<0.001
FEV ₁			
t value	0.536	3.344	6.269
p value	0.594	0.001	<0.001
PEFR			
t value	1.133	11.535	15.836
p value	0.136	<0.001	<0.001
FEF _{25-75%}			
t value	1.838	12.864	11.563
p value	0.070	<0.001	<0.001
FEV ₁ /FVC%			
t value	1.379	5.588	6.901
p value	0.172	<0.001	<0.001

DISCUSSION

Flour dust generated during the processing of cereal grains like rice, wheat, maize, corn, etc. induces acute and chronic changes in the respiratory system reflected by deranged lung function test parameters. Besides micro-particles of cereals, flour dust may contain other contaminants like silica, fungi, aflatoxins, pesticides, herbicides or other chemicals that irritate the respiratory lining and cause respiratory ailments.⁸

In our study we observed a significant decline in all the lung function parameters, viz., FVC, FEV₁, PEFR, FEF_{25-75%} and FEV₁/FVC%. Melo CA et al in a similar study at Navi Mumbai, Maharashtra, also reported a significant reduction in all these five lung function test parameters among flour mill workers compared to matched controls.⁹ However, Dhillon SK et al in a study from the Amritsar district of Punjab mentioned a significant decline in FVC and PEFR only.¹⁰ Nayak Y et al in their study also reported a significant reduction in all lung function test parameters except FEV₁/FVC among flour mill workers from Gujarat compared to their predicted values.¹¹

Many studies from other countries have also reported findings in support of our study.¹²⁻¹⁵ Mohammadien HA et al in a study from Egypt observed a highly significant reduction in all the lung function test parameters among flour mill workers compared to controls.¹² In a study from Ethiopia, all lung function test parameters except FEV₁/FVC in flour mill workers were significantly lower than controls.¹³ Another study from Karachi, Pakistan, also revealed a significant reduction in all the lung function test parameters except FEV₁/FVC and FEF_{25-75%} among flour mill workers compared to controls.¹⁴ However, Kakooei H and Marioryad H in a study from Iran reported a non-significant reduction in the ventilatory function of flour mill workers in contrast to controls.¹⁶

In the present study, with the increase in the duration of flour dust exposure, a significant decline in all the lung function test parameters was observed. The dose-response relationship between flour dust exposure duration and decline in lung function has been consistently reported in the literature.^{10,12,14,17,18} Chen P in their study not only observed impairment in lung function with exposure to flour dust for a longer duration but also reported a significant reduction in lung function parameters among high exposure workers compared to low exposure ones.¹⁷

In our study, flour mill workers with a duration of exposure of fewer than 5 years did not depict any significant decline in the lung function parameters (except PEFR) compared to controls. Further, the highest reduction in lung function parameters was observed in workers with an exposure duration of more than 10 years which is supported by findings of a study by Dhillon SK et al.¹⁰ This depicts cumulative damage to lung

function over longer periods of exposure and thus demands more attention to the workers with a long history of exposure to flour dust.

Significant impairment in the lung function of flour mill workers may also be attributed to inadequate availability and use, if available, of personal protective equipment at the workplace. Workers are not accustomed to wearing personal protective equipment because of a lack of awareness about their importance or unavailability of adequate equipment. Even if little equipment is available, they are not trained properly for using them. Further unfavourable environmental conditions especially, low ventilation in the dust generation areas may predispose workers in less developed countries to early and enhanced lung damage. Inadequate use of personal protective equipment by industrial workers has been mentioned in many studies from India,⁹ Ethiopia,¹⁹ and Nigeria.²⁰ This renders these workers more susceptible to adverse effects of occupational exposure with early and enhanced lung function impairment.

CONCLUSION

Flour dust affects the airways of flour mill workers resulting in significant impairment in the pulmonary function among them. Further, there is a cumulative dose-response relationship depicted by a progressive decline in lung function among workers with increasing duration of exposure to flour dust.

Limitations of the Study

The workers were not categorized according to their job profiles. Office workers, supervisory staff, drivers, etc are less exposed with better lung function compared to millers, packers, sweepers, etc who are exposed to higher dust levels. Further, the measurement of environmental dust levels at the workplaces of these workers was not measured.

Recommendations

For the prevention of lung function deterioration, a policy of pre-placement examination and periodic health surveillance of flour mill workers needs to be strictly enforced. Health surveillance includes eliciting flour dust exposure duration history, regular clinical examination and performing lung function testing periodically. Adherence to the use of personal protective equipment and provision of adequate ventilation at the workplace is equally important.

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