

LUNG FUNCTION AMONG NON-SMOKING WHEAT FLOUR MILL WORKERS

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Abstract

Objectives: Flour dust occurs across the range of food industries; its exposure may induce acute or chronic respiratory ailments. The objective of the study was to assess the effects of flour dust on the lung function. **Materials and Methods:** The lung function was studied in forty-six male flour mill workers and a similar number of male control subjects; all participants were non-smokers with the age range from 18 to 65 years. The subjects were matched for age, height, weight and socioeconomic status. The pulmonary function test was performed by using an electronic spirometer (Compact Vitalograph, UK) and results were compared by a paired t-test. **Results:** Significant reduction in the overall mean values of FVC, FEV₁, PEF, and MVV were observed in wheat flour mill workers relative to their matched controls. **Conclusions:** Based on the results of the present study, we conclude that the flour mill workers in Pakistan, like grain workers elsewhere, are at an increased risk of developing occupationally related pulmonary function impairments. The results suggest that there is an urgent need to improve dust control measures and the health status of flour mill workers.

Key words:

Occupational hazards, flour dust, respiratory ailment, pulmonary function test

INTRODUCTION

The work environment seriously influences the organism of exposed humans. The workers of agricultural industry are highly exposed to harmful factors in their work environment, such as dust, unfavorable microclimatic condition, excessive noise and insufficient light. Dust is treated as the most influential agent, and perceived as a frequent cause of the respiratory system illnesses. Occupational respiratory diseases are usually caused by extended exposure to irritating or toxic substances that may cause acute or chronic respiratory ailments, although severe single exposures can cause chronic lung disease as well. The occupationally related lung diseases are most likely due to the deposition of dust in the lungs and are influenced by

the sort of dusts, the period of exposure, the concentration and size of airborne dust in the breathing zone [1].

Many industries, including flour mills, generate dust, which is released into the air and later inhaled during industrial processes, such as cleaning, crumbling of the product, packaging and shipping [2]. Flour dust has a varied composition, including particles of husk, cuticular hairs, pollen, starch grains, bacteria, mucous spore, and particles of mineral origin (free silica) [3]. It may also contain a large number of contaminants, including fungi and their metabolites (aflatoxin), insects, mites, mammalian debris, and various chemical additives, e.g., pesticides and herbicides [4].

Flour dust is a hazardous substance with respiratory sensitizing properties. Owing to its irritating properties, it may

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give rise to respiratory, nasal and eye symptoms. In addition, flour and/or grain mill workers have been reported to exhibit a variety of clinical manifestations, including conjunctivitis, allergic and baker's asthma, wheezing, febrile reactions, grain fever, lung fibrosis, rhinitis, allergic alveolitis, impairment of lung function, and chronic obstructive pulmonary disease [5].

The occupationally related lung diseases are important aspects of clinical medicine. Spirometry plays a significant role in the diagnosis and prognosis of these diseases and describes the effects of restriction or obstruction on the lung function [6]. In view of the fact that flour dust puts the worker's health into jeopardy, this study was designed to investigate the effects of flour dust on the lung function. An additional aim was to reduce possible health risks in flour mill workers by providing information about the hazards of flour dust.

MATERIALS AND METHODS

The present study was conducted under the supervision of the Department of Physiology, College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia during the year 2002.

Study population

The author visited the Korangi industrial zone Karachi, Pakistan and the clinical history of approximately 80 flour mill workers was taken. Taking of the clinical history lasted several minutes to obtain a detailed clinical examination and to determine whether they would be included in the study or not on the basis of the exclusion criteria. They were questioned with regard to smoking cigarettes or other tobacco products, chewing tobacco or betel nut products. After initial interviews, 46 apparently healthy male flour mill workers with the mean age of 34.97 ± 1.90 years (mean \pm SEM; range, 18–65 years) and the mean duration of exposure 6.30 ± 0.39 years (mean \pm SEM; range, 1–10 years) were eligible for the study and 34 workers were excluded. These flour mill workers worked for at least 8–10 h/day and six days/week without using any self-protective measures. Controls were selected, in a similar manner to

that of the flour mill workers, from approximately 90 persons interviewed, 46 apparently healthy male control subjects were selected with the mean age of 35.08 ± 1.80 years (mean \pm SEM; range, 20–60 years). They were composed primarily of shopkeepers and salesmen. All subjects were matched for age, height, and weight and socioeconomic status. Overall, there were no significant differences in the anthropometric means in the combined data.

Exclusion criteria

Subjects with gross clinical abnormalities of the vertebral column, thoracic cage, neuromuscular diseases, known cases of gross anemia, diabetes mellitus, chronic bronchitis, emphysema, bronchial asthma, tuberculosis, ischemic heart diseases, malignancy, drug addicts, cigarette smokers, tobacco chewers and subjects who had undergone vigorous exercise, abdominal or chest surgery were excluded from the study.

Methods

Spirometry. Spirometry was performed on an electronic spirometer (Compact Vitalograph, UK). All pulmonary function tests were carried out at a fixed time of the day (9 a.m. – 1 p.m.) to minimize any diurnal variation [7]. The apparatus was calibrated daily and operated within the ambient temperature range of 20–25°C. The precise technique in executing various lung function tests for the present study were based on the manual operation of the instrument with special reference to the official statement of the American Thoracic Society of Standardization of Spirometry (1987) [8]. After taking a detailed history and anthropometric data, the subjects were informed about the whole maneuver. The subjects were encouraged to practice this maneuver before performing the pulmonary function test. The test was performed with the subject in standing position without using a nose clip. The test was repeated three times after adequate rest and results were obtained in the spirometer. These parameters were: forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), forced expiratory ratio ($FEV_1/FVC\%$), peak expiratory flow (PEF), forced expiratory flow ($FEF_{25-75\%}$) and maximum voluntary ventilation (MVV).

Table 1. Comparison of anthropometric parameters between flour mill workers and control subjects

Parameters	Control subjects (mean \pm SEM) n = 46	Flour mill workers (mean \pm SEM) n = 46	P
Age (years)	35.08 \pm 1.80	34.97 \pm 1.90	NS
Height (cm)	168.28 \pm 0.89	169.32 \pm 0.74	NS
Weight (kg)	65.41 \pm 1.03	65.00 \pm 0.81	NS

NS – not significant; P – significance level.

Statistical analysis

Statistical analysis was conducted using a paired t-test (two-tailed). The level of significance was established at a value of $p < 0.05$. The overall mean pulmonary function data were also correlated against the duration of exposure. Linear regression was applied in this correlation and the equation $y = mx + c$ was derived with the correlation coefficient (r), where “y” means spirometric value, “x” indicates years of exposure and “c” is a constant. The r^2 -value determined the level of the correlation significance.

RESULTS

Anthropometric studies

Table 1 demonstrates the comparison of the anthropometric parameters between the flour mill workers and their matched control subjects. There was no significant difference between the means of anthropometric parameters in terms of age, height and weight between the groups.

Table 2. Comparison of the overall lung function parameters between flour mill workers and control subjects

Parameters	Control subjects (mean \pm SEM) n = 46	Flour mill workers (mean \pm SEM) n = 46	Percentage change (%)	P
FVC (liters)	4.32 \pm 0.10	3.36 \pm 0.10	-22.23	$p = 0.001$
FEV ₁ (liters)	3.20 \pm 0.09	2.60 \pm 0.12	-18.75	$p = 0.001$
FEV ₁ /FVC%	74.13 \pm 1.40	76.52 \pm 2.30	+3.22	NS
PEF (liters/min)	359.56 \pm 17.47	268.70 \pm 20.85	-25.27	$p = 0.001$
FEF _{25-75%} (liters/sec)	3.38 \pm 0.19	3.16 \pm 0.20	-6.50	$p = NS$
MVV (liters/min)	120.04 \pm 3.56	97.63 \pm 4.71	-18.67	$p = 0.001$

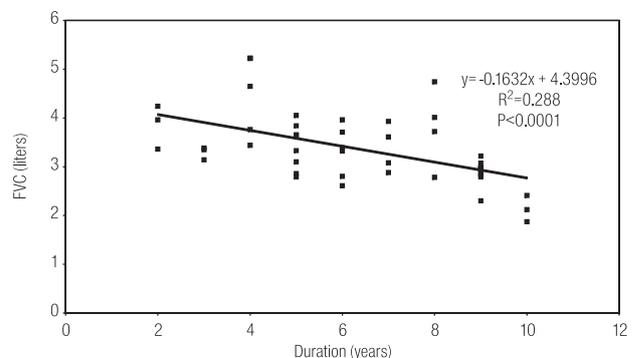
NS – not significance; P – significance level.

Pulmonary function test

The overall mean values of the lung function parameters for the total number of flour mill workers and their matched controls are presented in Table 2. The values of FVC, FEV₁, PEF and MVV were significantly decreased ($p < 0.001$) in flour mill workers as compared with their matched controls. However, no significant differences were observed in FEV₁/FVC and FEF_{25-75%} between the groups. The mean duration of exposure in flour mill workers was 6.30 \pm 0.39 years (mean \pm SEM; range, 1–10 years). The percentage change in the flour mill workers relative to control subjects is also shown.

Regression analysis

Regression analyses were performed on the overall mean pulmonary function data against the duration of exposure

**Fig. 1.** Regression analysis of forced vital capacity (FVC) against the duration of exposure of the flour mill workers, a negative significant correlation was found, indicating that the increased duration of flour dust exposure decreased the FVC value.

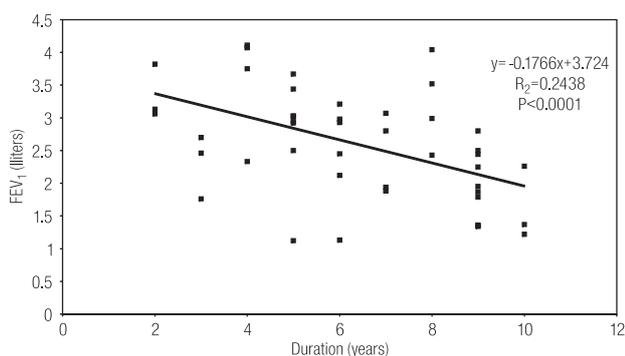


Fig. 2. Regression analysis of forced expiratory volume in one second (FEV_1) against the duration of exposure of the flour mill workers, a significant negative correlation was found, indicating that the increased duration of flour dust exposure decreased the FEV_1 value.

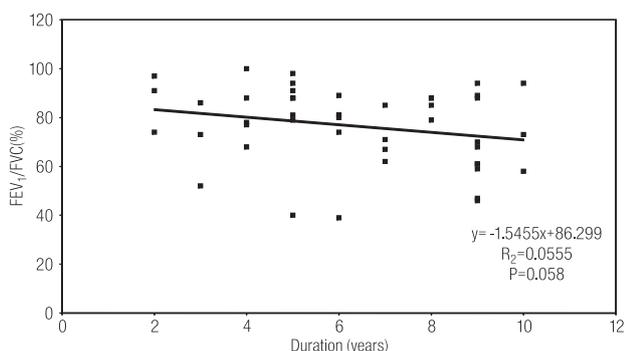


Fig. 3. Regression analysis of forced expiratory ratio ($FEV_1/FVC\%$) against the duration of exposure of the flour mill workers, an insignificant correlation was found, indicating that the increased duration of flour dust exposure insignificantly decreased the $FEV_1/FVC\%$ values.

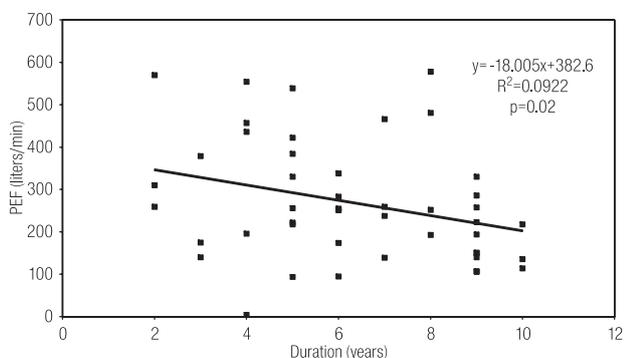


Fig. 4. Regression analysis of peak expiratory flow (PEF) against the duration of exposure of the flour mill workers, a significant negative correlation was found, indicating that the increased duration of flour dust exposure decreased the PEF value.

of the flour mill workers. Significant negative correlation for the r values were found for FVC ($p = 0.0001$), FEV_1 ($p = 0.0001$), PEF ($p = 0.02$) and MVV ($p = 0.0001$), as shown in Figs. 1,2,4,5, indicating that the increased dura-

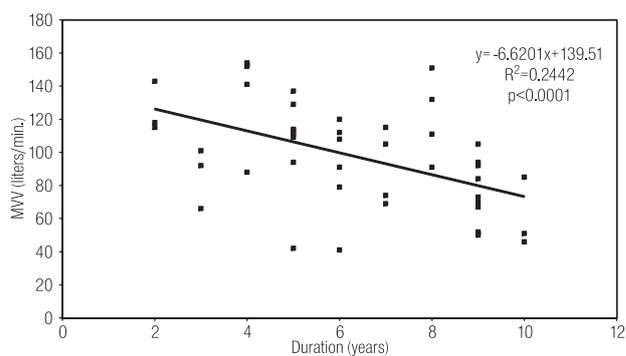


Fig. 5. Regression analysis of maximal voluntary ventilation (MVV) against the duration of exposure of the flour mill workers, a significant negative correlation was found, indicating that the increased duration of flour dust exposure decreased the MVV value.

tion of flour dust exposure diminished the lung function. However, insignificant correlation was found for $FEV_1/FVC\%$ ($p = 0.058$) as shown in Fig. 3.

DISCUSSION

Flour dust is a heterogeneous substance with respiratory sensitizing and irritating properties; its exposure may induce acute or chronic respiratory ailments [9]. Some investigators have reported normal pulmonary function and others observed abnormal lung volumes in workers exposed to flour dust. In addition, while conducting this kind of studies little consideration has been given to promising factors, which affect the lung function, such as age, height, weight, smoking or socioeconomic status. Therefore, this study was designed to investigate the effects of flour dust on the lung function in non-smoking wheat flour mill workers matched for age, height and weight. The results of the present study showed a significant reduction in the mean values of FVC, FEV_1 , PEF and MVV in the flour mill workers as compared with their matched controls as well as directly proportional impairment of their lung function parameters to the duration of exposure (Figs. 1, 2, 4, 5). In addition, the percentage change for FVC -22.23; FEV_1 -18.75; FEV_1/FVC +3.22; PEF -25.27; $FEF_{25-75\%}$ -6.50 and MVV -18.67 is decreased in flour mill workers. Bohadana et al. [10] showed that regardless of exposure to relatively low concentration levels of inspirable flour dust, subjects working in the baking industry are at risk of developing

respiratory symptoms and airway hyperresponsiveness. James et al. and Talini et al. [11,12] reported an increase in frequency of respiratory symptoms and decreased FEV_1 in a group of workers exposed to grain and flour dust. In addition, Gimenez et al. [13] have observed that flour dust exposure causes cough, phlegm production and the decreased pulmonary function values among flour mill workers compared to their matched controls. Similarly, Corzo and Naveda [14] reported a decrease in the values of PFR, $FEF_{25\%}$, $FEF_{75\%}$ and also demonstrated that the longer summative time of exposure to flour dust was associated with more diminished spirometric values. Awad et al. [15] also observed a significant decline in the lung function parameters, FVC and FEV_1 , in workers exposed to flour dust compared to the control group. Our results confirm the results observed by the latter authors [14,15]. Ige and Awoyemi [16] investigated the occupationally induced lung function impairment in bakery workers as a result of exposure to grain and flour dusts. They reported that the mean values of FVC, FEV_1 , PEF, and $FEV_1/FVC\%$ in the bakery workers were significantly lower than those of the control subjects. Zodpey and Tiwari [17] reported that the PEF value was significantly reduced in flour mill workers as compared to their controls. The decline in PEF was linked with dust exposure and its duration. The results of our study are in agreement with the observations made by those authors [16,17].

Shamssain [18] observed ventilatory function in non-smoking flour processing male bakery workers and reported that the exposed group had significantly lower forced expiratory indices than the control group. Mean percent predicted values for FEV_1 , $FEV_1/FVC\%$, $FEF_{25\%-75\%}$, and PEF were respectively, 11.2%, 20.0%, 31.0%, and 36.1% lower in the exposed group compared to controls. Our results are in harmony with the results observed by Shamsain [18].

Chen [19] divided the flour mill workers into high- and low-exposure groups and observed that FEV_1 , FVC, MEF and PEF were significantly decreased in the highly-exposed group. The findings indicated that exposure to high concentrations of dust for a long period of time impair the pulmonary function. In addition, Meo [20] studied

the relationship between dose responses and duration of exposure on the lung function in flour mill workers and observed that FVC, FEV_1 , PEF and MVV were decreased in flour mill workers compared to their matched controls and this impairment was significantly associated with the increased duration of exposure to flour dust.

The present study supports the findings of other researchers and suggests that flour dust adversely affects the pulmonary function parameters (FVC, FEV_1 , PEF, and MVV). While discussing the pathophysiological aspects of a drop in the values of the aforesaid lung function parameters, FVC is decreased in pulmonary obstruction, emphysema, pleural effusion, pneumothorax, pulmonary edema and poliomyelitis [21]. Similarly, the FEV_1 value is low in obstructive lung diseases and in reduced lung volume [22]. The decline in FEV_1 is a convenient standard against which we can measure marked declines in subjects with the history of chronic obstructive pulmonary disease (COPD) or in subject exposed to environmental pollutants [23]. Whereas, PEF provides an objective assessment of functional changes associated with environmental and occupational exposures and determines acute or chronic disease processes [24]. In patients with severe COPD, PEF is persistently low and represents collapsing of large airways [25]. In addition, MVV reflects the function of the entire ventilatory apparatus and depends upon the compliance of the thoracic wall and lungs, airway resistance and muscular force. MVV is profoundly reduced in patients with airway obstruction or emphysema [22,25].

In view of pathophysiological aspects and a drop in FVC, FEV_1 , PEF and MVV parameters, our results suggest that flour dust adversely affects the lung function and causes a restrictive pattern of lung function impairment. All those facts allow to conclude that the problem of effects of flour dust is of importance in that it highlights the need to reduce exposure and shows the magnitude of the effect on the population at risk. It is advisable therefore, that health risk should be reduced by the mutual collaboration between health officials, mill management and their workers in the area of implementation of protective measures, such as improvement of ventilation and use of individual protective devices. It is also suggested that the workers

should undergo pre-employment and periodic medical surveillance tests. These measures will help to identify susceptible workers so they can take additional preventive measures as well as medication.

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