

# Respiratory Symptoms, Pulmonary Function Tests and Sensitization to Wheat Flour Antigen Among Flour Mill Workers

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## SUMMARY

**Objective:** To determine the prevalence of respiratory symptoms, pulmonary function test (PFT) abnormalities and sensitization to wheat flour and mite antigens among flour mill workers.

**Methods:** 28 males (mean age  $\pm$  SD: 39.0 $\pm$ 9.8) employed in flour milling industry and as a control group 20 unexposed males (mean age  $\pm$  SD: 40.1 $\pm$ 7.4) matched for age, smoking habits and socioeconomic status who work at hospital were studied. All of the subjects filled a questionnaire for their respiratory symptoms. PFTs were performed. Skin prick tests were applied for detecting sensitization to wheat flour and mite antigens.

**Results:** Mill workers had a significantly higher prevalence of work related cough with phlegm (35.7 %), dry-cough (17.9 %), wheeze (10.7%), dyspnea (3.6%), nasal symptoms (7.1 %), eye symptoms (17.9 %) and throat itching (14.3 %) than the control group ( $p < 0.05$ ). Forced expiratory volume in one second (FEV<sub>1</sub>), forced expiratory ratio (FEV<sub>1</sub>/FVC), forced mid-expiratory flow between 25% and 75% of FVC (FEF<sub>25-75</sub>) and peak expiratory flow rate (PEF) were significantly lower in the exposed workers compared with the control group ( $p = 0.003$ ,  $p = 0.006$ ,  $p < 0.001$ ,  $p < 0.001$ ; respectively). No sensitization to mite antigens was detected among workers and control group. Positive skin prick tests to wheat flour allergens were present in 12 of 28 workers but in 1/20 of the control group. The difference between two groups was statistically significant ( $p = 0.004$ ). No significant correlation between symptoms, pulmonary function tests and positive skin prick test to wheat flour were detected.

**Conclusion:** Our study demonstrated that exposure to wheat flour dust is associated with a higher prevalence of respiratory symptoms, decline in pulmonary function tests and high sensitization ratios to wheat flour antigens in mill workers.

*Archives of Pulmonary: 2004; 1: .....*

**Key Words:** Wheat flour, organic dust, respiratory symptoms, PFT, skin prick test

## ÖZET

### Un Değirmeni İşçilerindeki Solunumsal Semptomlar, Pulmoner Fonksiyon Testleri ve Buğday Unu Antijenine Karşı Gelişen Sensitizasyon

**Amaç:** Un değirmeninde çalışan işçilerde solunumsal semptomların prevalansını, solunum fonksiyon testlerindeki (SFT) anormallikleri ve buğday unu ile mitelara karşı oluşan duyarlılığı ortaya koymak.

**Metod:** Un değirmeninde çalışan 28 erkek (ortalama yaş  $\pm$  SD: 39.0 $\pm$ 9.8 yıl) ve kontrol grubu olarak da hastanede çalışan benzer yaş, sigara içme öyküsü ve sosyoekonomik düzeyde olan 20 erkek olgu (ortalama yaş  $\pm$  SD: 40.1 $\pm$ 7.4 yıl) çalışmaya alındı. Tüm olgular solunum sistemi semptomları açısından bir anket formu doldurdular. SFT'leri yapıldı. Buğday unu ve mite antijenine karşı sensitizasyonu saptamak için deri prick testleri uygulandı.

**Bulgular:** Değirmende çalışan işçilerde iş ile ilişkili balgamlı öksürük (35.7 %), kuru öksürük (17.9 %), hırıltı (10.7%), dispne (3.6%), burun semptomları (7.1 %), göz semptomları (17.9 %) ve boğaz kaşıntısı (14.3 %) kontrol grubundan anlamlı derecede daha yüksek saptandı ( $p < 0.05$ ). Kontrol grubu ile kıyaslandığında; 1. saniye zorlu ekspirasyon volümü (FEV<sub>1</sub>), 1. saniye zorlu ekspirasyon volümünün, zorlu vital kapasiteye oranı (FEV<sub>1</sub>/FVC), zorlu ekspirasyon ortası akım hızı (FEF<sub>25-75</sub>), tepe ekspirasyon akım (PEF), işçilerde anlamlı derecede daha düşük saptandı (sırasıyla;  $p = 0.003$ ,  $p = 0.006$ ,  $p < 0.001$ ,  $p < 0.001$ ). Mite antijenlerine karşı ne işçilerde ne de kontrol grubunda sensitizasyon saptanmadı. 28 işçinin 12'sinde buğday ununa karşı pozitif prick testi saptanırken kontrol grubunda sadece 20 kişinin 1'inde pozitiflik saptandı. Farklılık istatistiksel olarak anlamlı idi ( $p = 0.004$ ). Buğday ununa karşı pozitif prick testleri ile semptomlar ve SFT'leri arasında anlamlı bir ilişki tespit edilemedi.

**Sonuç:** Çalışmamız un değirmeni işçilerinde; buğday ununa maruz kalmanın artmış prevalansta solunumsal semptomlara, SFT'lerinde azalmaya ve buğday ununa karşı yüksek sensitizasyona neden olduğunu gösterdi.

*Akciğer Arşivi: 2004; 1: .....*

**Anahtar Kelimeler:** Buğday unu, organik toz, solunumsal semptomlar, SFT, deri prick testleri.

*Bu çalışma ERS 2002 Kongresinde tartışmalı poster olarak sunulmuştur.*

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## Introduction

There is a growing consensus on the deleterious effects of organic dust on respiratory function in industrial workers. Studies indicate that the inhalation of organic aerosols causes the development of chronic respiratory symptoms and lung function changes (1-3).

Occupational and environmental exposure to grain dust can cause a spectrum of clinical syndromes including progressive irreversible airflow obstruction. Exposure response studies have shown that declines in lung function across the work shift are directly related to higher ambient concentrations of grain dust. Importantly, 15-year cumulative average dust exposures have been found to be directly related to chronic phlegm production, dyspnea on exertion and lower spirometric measures of lung function (4).

Wheat flour is a complex organic dust, with a large diversity of antigenic or allergenic components. The antigens involved can be wheat flour proteins themselves, flour parasites or technical additives such as enzymes (5). Wheat flour consists of water-soluble albumins, salt-soluble globulins, gliadins and glutenins. Albumins and globulins appear to be the most important proteins contributing to immediate hypersensitivity reactions to wheat protein (6).

The aim of this study was to determine the prevalence of respiratory symptoms, lung function abnormalities and their relationship to sensitization to wheat flour allergens and mite antigens among flour mill workers.

## Methods

28 males (mean age  $\pm$  SD: 39.0 $\pm$ 9.8) employed in flour mills and as a control group 20 unexposed males (mean age  $\pm$  SD: 40.1 $\pm$ 7.4) matched for age, smoking habits, occupational and socioeconomic status, who work at hospital were studied. For the workers, the inclusion criterion was being exposed to flour dust for the whole or part of their normal working shift, i.e. workers who had a requirement to enter milling, production or packing areas as part of their job.

The workers filled a questionnaire for organic dust exposure with additional questions formulated to

detect work related respiratory symptoms. The questionnaire was administered as a face to face interview.

The interview procedure with questionnaire covered the following points;

- Episodes of wheezing or chest tightness.
- Symptoms of shortness of breath, dyspnea, cough, phlegm.
- Symptoms of sneezing, runny nose or blocked nose.
- Eye symptoms, throat itching.
- Time of onset of symptoms.
- Duration of symptoms.
- Relationship of symptoms to work, i.e. whether they were worse at work or at home, whether only arose exclusively at work
- If symptoms were relatively persistent, whether there was an improvement while from work during rest periods or on holiday.
- Whether treatment had been taken for the symptoms.

PFTs were performed by using a portable spirometer (MIR Spirobank). Measurements were performed following the recommendations of the American Thoracic Society (7).

FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC, PEF, FEF<sub>25-75</sub> and their predicted % values were determined.

Sensitization to wheat flour and mite antigens were evaluated with skin prick tests. Skin prick tests were read after 20 minutes and were considered to be positive if there was a wheal of at least 5 mm in diameter or larger than 70% of positive control.

Airborne dust (total and respiratory fraction) was sampled during an 8-h work shift in all the work places of the workers examined. Dust sampling was performed by using a Casella AFC 123 machine. Dust concentrations were determined by gravimetric analysis.

Statistical analyses were performed using the SPSS 9.0 statistical package program. Mann-Whitney U test was used to compare the groups according to age, PFT parameters. Fisher's  $\chi^2$  test was used when comparing the groups for presence of respiratory symptoms and sensitization to wheat antigen. If the p value <0.05, the difference was considered as statistically significant. Pearson's regression-correlation test was used for analyzing relation between skin prick test results and working year, PFT and respiratory symptoms.

## Results

28 males (mean age  $\pm$  SD: 39.3 $\pm$ 9.8; range 20-60 years) employed in flour-milling industry were studied to assess the prevalence of chronic work related respiratory symptoms, the presence of lung function abnormalities and sensitization to wheat flour and mite antigens. As a control group 20 (mean age  $\pm$  SD: 40.1 $\pm$ 7.4; range 30-65 years) unexposed subjects were studied. The demographic characteristics of workers and control group were summarized at Table I.

### Respiratory symptoms

The prevalence of chronic respiratory and irritati-

**Table I: Demographic characteristics of workers and control group.**

	Workers n=28	Control Group n=20
Mean age	39.3 $\pm$ 9.8	40.1 $\pm$ 7.4
Working year	10.7 $\pm$ 8.1	10.4 $\pm$ 6.4
Smoker	19 (69%)	9 (45%)
Ex-smoker	5 (18%)	6 (30%)
Non-smoker	4 (13%)	5 (25%)
Package-year	18.87 $\pm$ 12.63	21.13 $\pm$ 11.51

**Table II: Work related respiratory symptoms in flour mill workers.**

Symptoms	n (28)	%
Cough with phlegm	10	35.7
Dry cough	5	17.9
Wheezing	3	10.7
Dyspnea	1	3.6
Eye symptoms	5	17.9
Nose related symptoms	2	7.1
Throat itching	4	14.3

**Table III: The mean PFTs values of workers and control group.**

PFT	Workers		Control		p	
	Actual (lt)	Predicted %	Actual (lt)	Predicted %	Actual	Predicted %
FVC	3.95 $\pm$ 0.70	93.07 $\pm$ 10.40	4.26 $\pm$ 0.80	93.17 $\pm$ 16.90	p=0.15	p=0.98
FEV <sub>1</sub>	3.20 $\pm$ 0.60	90.75 $\pm$ 13.00	3.84 $\pm$ 0.70	101.38 $\pm$ 21.20	p=0.003	p=0.04
FEV <sub>1</sub> /FVC	82.01 $\pm$ 10.00	101.71 $\pm$ 12.00	90.08 $\pm$ 8.70	112.14 $\pm$ 10.60	p=0.006	p=0.003
PEF	6.11 $\pm$ 2.00	71.18 $\pm$ 19.40	9.02 $\pm$ 1.90	99.57 $\pm$ 19.10	p<0.001	p<0.001
FEF <sub>25-75</sub>	3.38 $\pm$ 1.00	80.86 $\pm$ 23.400	4.73 $\pm$ 1.40	107.24 $\pm$ 32.80	p<0.001	P=0.002

on symptoms in exposed workers was presented at Table II. The prevalence work related symptoms such as cough with phlegm (10/28), dry cough (5/28), Wheezing (3/28), eye symptoms (5/28) and throat itching (4/28) were significantly higher at wheat flour dust exposed workers when compared with the control group. The most common complaints related with work were cough with phlegm (35.7 %) and dry cough (17.9 %). Neither the workers nor the control group had chronic bronchitis.

The prevalence of morning cough and phlegm were significantly higher among workers who worked more than 20 years (4/5) when compared with the workers who worked less than 20 years (7/23) (p=0.04).

### Lung Function

The lung function tests in workers and control group were presented at Table III.

The values of FEV<sub>1</sub>, FEV<sub>1</sub> %, FEV<sub>1</sub>/FVC, FEV<sub>1</sub> /FVC %, FEF<sub>25-75</sub>, FEF<sub>25-75</sub> %, PEF, PEF % of workers were significantly lower than the control group.

Cigarette history was positive in 87 % of workers (both current smokers and ex-smokers). The mean PFT values of smoker workers were not significantly different from non smoker workers.

The FEF<sub>25-75</sub>, FEF<sub>25-75</sub> %, FEV<sub>1</sub>/FVC, FEV<sub>1</sub>/FVC% values were significantly lower among smoker workers when compared with the smoker control group (p=0.006, p=0.015, p=0.003, p=0.001; respectively).

There was no correlation between working year and PFT parameters.

### Sensitization

Positive skin prick tests to wheat flour antigens were present in 12/28 of workers but 1/20 of the control group. The difference between two groups was statistically significant (p=0.004).

No significant correlation between symptoms, pulmonary function tests and positive skin prick test to wheat flour were detected. No relation between the working year and positive skin prick test was detected. No sensitization to mite allergens was detected among workers and control group.

#### **Environment Dust Measurement**

Respirable dust concentrations varied 0.759-2.321 mg/m<sup>3</sup>.

#### **Discussion**

The findings of this study suggest that wheat flour dust is responsible for the development of chronic respiratory symptoms and lung function abnormalities. A significantly higher prevalence of chronic respiratory symptoms in the group of exposed workers than in the control group was found. Smith T.A. et al studied respiratory symptoms at flour millers and 22% of workers described upper respiratory symptoms of some kind in their study (2). The authors categorized most of these symptoms as non-specific respiratory irritation. They detected on closer questioning, there had been characteristically a clear temporal association between the respiratory symptoms and exposure to high levels of dust (2).

Zuskin et al. studied respiratory function and immunological status of 53 flour processing workers. They found a high prevalence of chronic respiratory symptoms in exposed workers. They recorded the highest prevalence for cough (50.9%) and for eye irritation (54.7%) during the work shift (8). Similar to these findings, the highest prevalence for cough (cough with phlegm; 35.7% and dry cough; 17.9% ) was detected in this study, beside that eye irritation prevalence was 17.9%. Zuskin et al. determined the dust concentrations higher than recommended in their working environment, the dust concentrations was in normal standards in our study. The difference in the working conditions may be the explanation for detecting higher prevalence of symptoms in their study.

Reactions of the respiratory system to organic dust may potentially be caused or aggravated by a number of different mechanisms including non-specific airway irritation, allergic reaction to antigens in organic dust or inflammatory potential of

the dust. Bronchial hyperresponsiveness may be a common feature of early respiratory disease resulting from the exposure to organic aerosols . Hyperresponsiveness may be due to increased permeability of the airway mucosa to irritants secondary to epithelial damage, resulting in a direct effect on airway smooth muscle (1). The frequent reporting of cough and irritation symptoms for nose and throat by a large number of workers in our study suggests that damage to the airway mucosa may have a primary role in the pathogenesis. Immunological studies indicate that immune responses are frequent among workers in flour milling industry and may partly explain the airway reactions to wheat flour (5,9,10). However, atopic exposure to workplace antigens is in general very common and may be nonspecific (1). Positive skin prick tests to wheat flour antigens in our study was found in 12/28 of workers. There was no correlation between symptoms and positive skin prick test to wheat flour antigen. Smith T.A. et al. studied respiratory symptoms and wheat flour sensitivity in flour millers, they found the prevalence of positive skin prick tests to wheat flour antigens as 1.2% (2). Smith T.A. et al explained the low prevalence of allergic conditions by healthy worker effect. According to the authors the presence of a positive test in the presence of symptoms does not necessarily infer a causal relationship (2). The findings of Zuskin et al. indicated, as in our study that while immunological reactions were frequent in organic dust exposed workers they were not generally well correlated with respiratory symptoms (11-14).

Pulmonary function testing is an essential means for diagnosing airways disease. Changes in lung function have been reported in animal food processing workers (15,16), coffee workers (1), textile workers (17), fur workers (1), spice factory workers (1) and in bakers (18,19). Xu et al. found a significant decrease for FEV<sub>1</sub> and FVC with high dust exposure levels and suggested that nonspecific occupational dust exposure is a risk factor for development of chronic obstructive respiratory disease (3). Significantly lower values of FEV<sub>1</sub>, FEV<sub>1</sub> %, FEV<sub>1</sub>/FVC, FEV<sub>1</sub> /FVC %, FEF<sub>25-75</sub>, FEF<sub>25-75</sub> %, PEF, PEF % were found in workers when compared with the control group. Heederik et al. demonstrated that occupation is clearly related to

chronic nonspecific respiratory disease and reduced FEV<sub>1</sub> is a strong predictor of the incidence of chronic respiratory disease (20).

Similar to the results of this study, Zuskin et al. was reported the mean percent predicted values of FEV<sub>1</sub>, FEV<sub>1</sub>/FVC, FEF<sub>25-75</sub> and PEF as respectively 11.2%, 20.0%, 31.0% and 36.1% lower in the exposed workers when compared with the controls (8). In our study the mean PFT values of wheat flour exposed workers were significantly lower from the unexposed control group. Wheat flour dust exposure might be the cause of decline in lung functions.

### Conclusion

Our study demonstrated that exposure to wheat flour dust is associated with a higher prevalence of respiratory symptoms, decline in pulmonary function tests and high sensitization ratios to wheat flour antigen in mill workers. Dust concentrations should be monitored and kept below accepted standards. Pulmonary function tests should be performed before employment and periodic tests should be carried out at regular intervals.

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