

Respiratory effects of exposure to flour dust: A case study among workers of flour production factories in Arak

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ABSTRACT

Flour dust has been introduced as one of the effective factors in the prevalence of respiratory disorders among the workers of the flour production factories. The purpose of the present study is to examine the effects of this pollutant on the pulmonary functions and survey the prevalence of respiratory symptoms among workers of flour production factories in Arak, Iran. Exposure to flour dust is used to classify subjects into exposed (38 male workers of production plant) or unexposed groups (37 male employee from administrative section). Exposure level to flour dust, the prevalence of respiratory symptoms and pulmonary function in two group were studied using air sampling (based on method NIOSH 0600), a researcher made questionnaire on respiratory symptoms and Spirometer, respectively. The results indicated that workers of the production plant are exposed to high concentration of flour, which causes a decrease in the ratio of FEV1 / FVC compared to the unexposed ones. Among study respiratory symptoms, subjects had reported significantly more sputum secretion than that in control group. Furthermore intervening parameters, including age, work experience, body mass index and smoking didn't show a significant effect on the pulmonary function of the individuals. Exposure to flour dust concentration with higher than threshold level values causes a decrease in workers respiratory capacity. Therefore, it is recommended that the reduction of both exposure risk and the 8-hour time-weighted average concentration of flour dust should be considered.

Key words: Flour dust; Respiratory symptoms; Pulmonary function.

INTRODUCTION

Wheat flour is a complex organic particle containing a wide variety of allergens and antigenic particles. Workers of flour production factories and different kinds of bakeries are subject to the complications resulting from exposure to these particles [1], including respiratory disorders with different natures and severities from simple stimulatory symptoms to allergic rhinitis and occupational asthma [2].

Allergens which contribute to these complications include three important ones: flour proteins, microorganisms accompanying flour such as molds, worms and also flour additives, esp. ferment and amylase's compounds. Sensitivity to one or more

groups of these allergens can lead to an increase in the prevalence of respiratory symptoms as well as increase in reactivity of airways of workers. Among the mentioned allergens, flour proteins play a significant part in lung disease prevalence[3].

According to previous studies on work environment, airborne flour particles have been considered a cause of respiratory disorders; so that, higher flour dust concentration (more than threshold limit values), higher prevalence of respiratory symptoms. The occurrence of flour-related respiratory diseases depends on different factors, including air dust concentration, duration of exposure and other characteristic such as individual sensitivity and genetics [4-5].

American Conference of Governmental Industrial Hygienists (ACGIH) proposed a Threshold Limit Value (TLV) 0.5 mg/m³ for inhalable flour dust which has been approved by Iran's technical committee of occupational health³. Results of several studies indicate that the average concentration of inhalable flour dust is higher than the TLV in the flour production plants [6-7] in which airborne flour particles are produced during the processes of purifying, grinding, bag-packing and handling. This causes a decrease in the index of pulmonary function in their workers, especially in mixing and packing sections[7-9]. When workers deal with flour dust for a long time and the dust are inhaled continuously, esp. in those with allergic history, it causes a kind of occupational asthma known as baker's asthma. However, incidence of symptoms like shortness of breath, wheezing, rhinitis, asthma, immunologic changes, chronic bronchitis can be seen over time, even in those who have no allergy[10]. To diagnose various lung conditions, spirometry test can be helpful and it can indicate the incidence of the disease before any obvious respiratory symptom [11]. Considering the respiratory effects induced by flour dust, the present study aimed to assess the effects of flour dust exposure on the prevalence of respiratory symptoms as well as on the incidence of disturbances in pulmonary function among workers involved in flour production in Arak, Iran.

MATERIALS AND METHODS

Study population

The study has been conducted on the workers of all three factories which produced flour in Arak city. Arak is located in the central plateau of Iran. In the process of flour production in the factories, first the preliminary tests have been done for assessing the quality of the wheat grains, then they are purified, moistened, grinded and enriched; all the stages are highly mechanized. Finally, the flour is sent to the loading section for bag packed.

75 men who had at least a two-year work experience, entered the study with informed consent. Exposure to flour dust is used to classify subjects into exposed (38 male workers of

production plant) or unexposed groups (37 male employee from administrative section).

The individuals in two group were identical considering the parameters of age, body mass index, work experience, smoking history and health behaviors. The exposed group worked in production (13 people) and loading section (25 people) and they were exposed to flour dust for at least 8 hours per day.

Exposure assessment

For both exposed and non-exposed (office employee) groups, air personal sampling and flour dust were done according to the NIOSH (National Institute for Occupational and Safety), Method 0600[12] using PVC filter (0.5 µm pore size, 37 mm diameter, SKC Inc., USA), personal sampling pump (224-PCMTX8, SKC) and nylon cyclone.

The gravimetric method was employed in accordance with NIOSH 0600, using pre-weighed 37-mm PVC filters and a sensitive microbalance (CP225D, Sartorius Co., USA). Filters were placed in the desiccators at least 48 hours before and after of sampling. Pump was operated at a constant flow rate of 2 l/min were used for the sampling. Environmental parameters such as air temperature and pressure were measured, using WBGT meter (HB3279-03-Casella CEL, U.K.) to estimate the real sampling flow rate.

Spirometry test

To study the pulmonary function, spirometry test was done on all subjects who have been trained to do test, before entering to workplaces by an occupational medicine specialist. A Spirolab II (MIR Medical Research International S.R.L, Rome, Italy) was used for spirometry tests. After repeating tests for at least three times, the ratio of FEV₁/FVC was recorded.

Respiratory symptoms

To estimate the prevalence of respiratory symptoms among participants and assess their demographic characteristics, all participants completed a researcher-made questionnaire. It included four parts:

- Demographic characteristics (age, weight, height, work experience and smoking history)
- Work history (moreover, considering all their activities during and after work shift)

- Medical history (like history of cardiovascular and respiratory disease or seasonal allergy)
- The common respiratory symptoms based on the prevalent symptoms in backer's asthma (including coughing, sputum, shortness of breath, wheezing, rhinitis and respiratory track irritation).

Statistical analyses

All statistical analysis were done using SPSS version 20 (SPSS, Inc, Chicago, IL). The Kolmogorov-Smirnov statistical test was done for checking the degree of normality of obtained data. Cross-group comparisons were made using Student's t-test, one- or two-way analysis of variance (ANOVA). Chi-square test was used to assess the association between categorical variables. Pearson's correlation coefficients were used to assess the relationship between the interesting variables. The significance level was set at 0.05.

RESULTS

Demographic characteristics of production workers and office employee have been presented in Table1. Results of chi- squared test didn't show any significant difference between the two groups in terms of demographic variables (P-value>0.05). Measurement results of the inhalable

dust (Table2) indicated that concentration in both operational units was more than the threshold limit value-time weighted average (TLV-TWA) recommended by ACGIH and in loading section it was higher than that in production. The study of the prevalence of respiratory symptoms revealed that coughing is the most common respiratory symptom in both group (Table3). Among study respiratory symptoms, subjects had reported significantly more sputum secretion than that in control group. (P-value=0.03, chi- squared test). According to the average of the data obtained from spirometry test, the respiratory function of the office employees (FEV1/ FVC (%): 87.7 ± 5) was better than that of the production workers (FEV1/ FVC (%): 81.2 ± 4.5), and Student's t-test showed a significant statistical difference of mean FEV1/ FVC between the two groups (P-value<0.05). According to the results of two – way variance analysis test, the demographic variables work experience (P-value=0.534), age (P-value=0.614), body mass index (P-value=0.473) and smoking (P-value=0.248) don't have a statistically significant effect on the respiratory functions between the exposed and unexposed groups.

Table 1. Characteristics (Mean (\pm SD)) of the study population

Characteristics	Exposed group	Unexposed group	P-value
Age (yr)	35.3 \pm 8.2	33.7 \pm 10.8	0.74
Work history (yr)	6.4 \pm 1.2	5.3 \pm 1.6	0.76
BMI (kg/m ²)	23.5 \pm 2.9	22.5 \pm 3.5	0.06
No. of smokers (%)	31.6	21.6	0.33

Table 2. Concentrations of respirable flour dust (mg/m³)

	Task category	Mean (\pm SD)
Exposed group	Producing (n=9)	3.2 \pm 0.78
	Loading(n=9)	4.6 \pm 1.10
	Total (n=18)	3.9 \pm 1.20
Unexposed group(n=9)		0

Table 3. Prevalence of respiratory symptoms

Symptoms	Exposed group		Unexposed group		P-value
	Number	Percent	Number	Percent	
Frequent Coughing	10	26.3	8	21.6	0.63
Sputum	7	18.4	1	2.7	0.03
Shortness of breath	6	15.8	3	8.1	0.31
Wheezing	4	10.5	5	13.5	0.69
Rhinitis	5	13.2	5	13.5	0.96
Respiratory Track Irritation	2	5.3	0	0	0.16

Table 4. The relationship between prevalence of signs and symptoms of respiratory disease and pulmonary function and flour dust concentration

Sign and symptom	Pearson correlation coefficient	P-value
Frequent Coughing	0.008	0.962
Sputum	-0.192	0.248
Shortness of breath	0.002	0.990
Wheezing	-0.191	0.250
Rhinitis	0.091	0.586
Respiratory Track Irritation	-0.269	0.103
FEV ₁ /FVC	-0.388	0.016

The relationship between prevalence of symptoms of respiratory disease and pulmonary function and flour dust concentration has been tabulated in Table 4. Pearson correlation test showed a reverse and significant relationship between the respiratory function (mean FEV₁/FVC) of exposed workers and the level of exposure to flour dust. In other words, it can be said that the higher concentration of flour dust in breathing zone, the more decrease in pulmonary function. Also, it is concluded that the higher concentration of flour dust, the more respiratory symptoms (coughing, shortness of breath and rhinitis) seen in the workers. Although these differences weren't statistically significant.

DISCUSSION

Allergens present in workplaces cause more than 15% of occupational disease and can lead to an increase of disorders and disabilities among workers.

These allergens can cause the incidence of respiratory diseases such as rhinitis, bronchitis and asthma. Flour producers are daily exposed to lots of allergens among which the role of flour protein as a potential allergen is more essential [3]. In the present study concentration of inhalable flour dust in three flour production factories in Arak city with averages of 3.2 and 4.6 mg/m³ in production and loading sections, was about 6.5 to 9 times higher than the recommended standard, respectively. Others studies also indicate that the concentration of inhalable flour dust in flour production factories is higher than TLV-TWA recommended by ACGIH [13-14]. Kakooei and Marioryad, and Bagheri et al. have determined the concentration of flour dust about 4.99 mg/m³ and 5.09 mg/m³, respectively [6,15].

It has been seen that exposure to concentrations higher than TLV result in an increase in the incidence of respiratory symptoms and a decrease in lung capacity of workers [8-9].

According to our results, among respiratory symptoms, 18.4% of expose group had sputum which was significantly higher than the unexposed group (prevalence rate 2.7%). This finding is consistent with observation by Bagheri et al in which prevalence of sputum in workers exposed to flour is higher than that in control group [15]. Sander et al concluded that 60- 70% of the workers exposed to flour dust have sensitivity to allergens of flour protein, which can lead to the increase in respiratory symptoms [16]. Moreover, the significant relationship has been seen between exposure to flour dust and incidence of respiratory symptom [17-18]. Although we can't see any statistically significant difference between two groups with respect respiratory symptoms expect for sputum. Kakooei and Marioryad reported the higher incidence of respiratory symptoms among flour production workers than control ones and these differences were statistically significant only for morning sputum [6].

The data of pulmonary function test showed that the mean FEV₁/FVC was higher in office employee than that in exposed workers and the demographic characteristics like age, work experience, body mass index and smoking history don't have significant effect on the changes in the pulmonary function. Ijadunola et al indicated that there was a decrease in the FEV₁ in workers exposed to flour dust [19]. It has been shown respiratory function of flour production workers is significantly less than of control group and the increase of work experience can have a significant effect on lung function [20-22].

A decline in pulmonary capacity of workers comparing to control group has been seen by Kakooei and Marioryad, but the difference was not statistically significant [6]. The study conducted by Meo and AL-Dress revealed that the respiratory capacity of workers with long time exposure to flour dust was significantly lower than of worker with short exposure [5]. Bagheri et al found that with increasing age and work history, lung volumes reduced [15]. However, the effect of age on respiratory function of workers exposed to flour dust has been reported controversially; so that some studies have found that getting older will reduce the incidence of pulmonary disorders and respiratory symptoms [23-24]. The negative effect of smoking on the pulmonary function has been reported a lot [25-26], however Ajeel et al reported that there was no evidence of significant relationship between respiratory disability and smoking [22].

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CONCLUSION

The present study indicated that exposure to flour dust higher than the acceptable limits can cause an increased risk of pulmonary disease. Therefore it is necessary to adopt the control measures such as improving air conditioning system, using effective personal protection equipment, taking pre-employment and periodic medical examinations to assess pulmonary function of the workers.

Also for drawing a definite conclusion, doing more researches recommends to study the effect of more potential confounding factors on the level of exposure, incidence of pulmonary function and respiratory symptoms.

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