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## Respiratory Complaints and Spirometric Parameters in Tile and Ceramic Factory Workers

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### ABSTRACT

**Background:** Respiratory disorders are among the most common occupational diseases. Tile and ceramic industry is quite popular in Iran and workers in this industry are exposed to harmful dust particles affecting their respiratory system.

**Materials and Methods:** This study was conducted in a tile and ceramic factory. The study group consisted of factory workers of the production units; whereas, the control group included the executive employees of the factory. A questionnaire was designed covering all the required data. There were a total of 411 workers. After considering the exclusion criteria, 243 workers in the study group were compared with 168 controls in terms of their respiratory status.

**Results:** Respiratory complaints were significantly higher in the study group compared to controls ( $p=0.023$ ). Frequency of abnormal spirometric findings was significantly higher in the study group ( $p<0.001$ ). A significant correlation was found between the occupational exposure to tile and ceramic dust and abnormal spirometric findings after adjusting for age, duration of employment and smoking habits ( $p<0.05$ ).

**Conclusion:** Our study results demonstrated that occupational exposure to ceramic and tile dust can harm workers' respiratory system. Therefore, it is recommended to diminish workers' exposure to tile dust by proper implementation of respiratory protection programs. Also, filling out the standard respiratory questionnaire and performing the pulmonary function tests are advised for workers in their periodic examination programs. (*Tanaffos* 2009; 8(4): 19-25)

**Key words:** Respiratory complaints, Occupational exposure, Pulmonary function tests

### INTRODUCTION

Pulmonary diseases are among the common causes of absence from work and early retirement in working populations. These diseases are responsible for 14% of work day loss among men and 11%

among women (1). Occupational exposure to harmful dusts is among the main causes of pulmonary diseases like asthma and bronchitis (2,3). Exposure to respirable dust particles in the work environment is a potential risk factor for chronic pulmonary diseases and workers may develop various respiratory disorders as the result of long term exposure to respirable mineral and organic dusts in an occupational environment (4). Previous studies

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have demonstrated that 11-19% of respiratory diseases in men and 4-5% in women are due to occupational exposure (5,6) and chronic obstructive pulmonary disease in 15-20% of cases is caused as the result of occupational exposure (7). Occupational respiratory diseases are preventable. However, their incidence rate is rising among workers due to the ongoing use of new chemical agents in the industries, insufficient control of harmful agents in the work environment and inadequate screening and medical care for the employees (8).

Tile and ceramic industry is among the industries in which workers are frequently exposed to harmful dust particles. During the last two decades, tile and ceramic industry has greatly expanded in Iran and the number of individuals working in this field has increased accordingly. The main process of tile and ceramic manufacturing include ball mill, preparation, press, mucilage production and furnace (9). Clay, silica, kaolin, mica, feldspar, bentonite, calcium carbonate, zirconium silicate and aluminum oxide are the major raw materials used for tile and ceramic production (9). Factory workers are exposed to dust particles in many phases of tile production and therefore are susceptible to occupational respiratory diseases. Exposure to dust particles of crystalline silica, mica, talc, kaolin, quartz, and tridymite is common among tile and ceramic factory workers and may result in developing pulmonary fibrotic diseases (4,9). Prolonged exposure to silica and other dust particles can predispose workers to develop silicosis, lung cancer and chronic obstructive pulmonary disease (COPD) (10,11). Various studies have demonstrated that long-term inhalation of ceramic dust during the process of ceramic production has been associated with increased risk of pneumoconiosis, chronic bronchitis and ventilation disorders in both male and female ceramic workers (12-14). Rushton in his study in 2007 pointed to the

increased risk of COPD in several occupations including the ceramic work (15). Neghab and colleagues in their study in 2009 on Shiraz tile industry showed a higher prevalence of respiratory complaints including cough, wheezing, phlegm and shortness of breath in workers exposed to raw materials used in ceramic production. Likewise, significant decrements in some parameters of pulmonary function were noted (16). Halvani et al. in their study on workers of tile factories in Yazd found a significant correlation between exposure to tile and ceramic dust particles and increased prevalence of respiratory symptoms. However, pulmonary function tests did not show a significant reduction (9). On the other hand, another study on pottery workers in Italy showed a significant decrease in spirometric parameters of exposed workers (17). Tile and ceramic manufacturing is a popular industry in Iran and there are a large number of workers exposed to harmful respirable dust in these factories. Therefore, this study aimed to evaluate the effect of tile and ceramic dust particles on respiratory system and pulmonary function parameters of exposed workers. Our study results may be useful in preventing respiratory disorders in these workers.

## MATERIALS AND METHODS

**Study design and understudy population:** This descriptive analytical study was conducted on workers of a tile and ceramic factory in Yazd city in 2009. All the production unit workers who were exposed to tile and ceramic dust and were all males entered the study and comprised the study group. The main factory units included the ball mill, the press, the preparation unit, the mucilage, and the furnace. Clay, silica, kaolin, mica, feldspar, bentonite, calcium carbonate, zirconium silicate and aluminum oxide were the raw materials used by workers for tile and ceramic production. In this process, workers are

exposed to different concentrations of respirable and inhalable dust particles that may adversely affect their respiratory system. In this study, male employees of the executive unit of the factory were considered as the control group. Workers with less than 1 year employment history in their current job, those with a second job or a previous job that included exposure to respiratory risk factors, workers with positive history of respiratory diseases (prior to their current employment) and those with a history of thoracic surgical operations, history of allergic diseases, positive familial history for allergy or a history of acute respiratory infection in the last 4 weeks before the initiation of this project were excluded from the study. There were 251 male workers in the production unit and 172 male workers in the executive unit of the factory. After applying the exclusion criteria, 243 workers were remained in the study group and 168 in the control group.

**Questionnaire and clinical examination:** The respiratory questionnaire was designed according to the American Thoracic Society (ATS) standard questionnaire (18) with a few changes and was filled out for all the understudy subjects. The questionnaire included the demographic data, medical history, familial history, respiratory complaints (cough, sputum, dyspnea, wheezing, etc) at work or at home, positive history of allergy and asthma, medication consumption, smoking habits (evaluated by the number of packs per year), other diseases, respiratory complaints before the current employment and detailed job description (type of work, potential risks, previous job, etc). After filling out the questionnaire, all the understudy subjects were clinically examined by 2 physicians with special attention to their respiratory system.

**Measuring the concentration of dust particles:** Measurement of total dust particles and the respirable and inhalable dust particles was performed by using

SKC air sampling pump (model 224-30) calibrated and equipped with filter holder containing a 25mm membrane filter and 0.45 micron (diameter) pores connected to the cyclone (UK, London, Casella). Sampling was performed at the flow rate of 2 lit/min and in the breathing zone of workers. Dust concentration was measured by gravimetry. By weighing the filter before and after filtration of the air (SD=0.1 mg) respirable dust concentration was calculated and by weighing the cyclone contents the total concentration of all dust particles was determined. The mean dust concentration in different production units is demonstrated in Table 1. It showed that the dust concentration in all production units was above the maximum exposure limit (the safe limit is 3 mg/m<sup>3</sup> for respirable dust particles and 10 mg/m<sup>3</sup> for total dust particles (19). Dust concentration was insignificant in the executive units.

Table 1. Total and respirable dust concentrations measured in the air sampled in different production units of the factory.

Location	Total dust Mean (mg/m <sup>3</sup> )	Respirable dust Mean (mg/m <sup>3</sup> )
Ball mill	46.7	23.0
Preparation unit	40.1	23.4
Press	52.0	35.7
Mucilage	54.0	31.0

**Pulmonary function test** All understudy subjects underwent closed-circuit spirometry by a calibrated portable spirometer (Spirolab III, MIR Co., Italy). All phases of the test, recommendations for preparing the workers and executive personnel before performing the test, the primary settings of the device (adjusting the environmental condition, etc), method of performing the test and interpreting the results were all according to the guidelines provided by the American Thoracic Society (20-22). The test was conducted by a trained physician between 8-10 am

everyday in a sitting position for all subjects. We used the following spirometric indices for reporting the obtained results:

- 1- Forced expiratory volume in one second (FEV<sub>1</sub>)
- 2- Forced vital capacity (FVC)
- 3-  $\frac{FEV_1}{FVC}$
- 4- Forced expiratory flow between 25% and 75% of the FVC (FEF<sub>25-75%</sub>)
- 5- Peak expiratory flow(PEF)

Understudy subjects were categorized into 4 groups of 1) normal 2) obstructive 3) restrictive, and 4) mixed based on their spirometric findings (22).

**Data analysis and statistical tests:** SPSS software version 15 was used for data analysis. Percentage, frequency, mean and standard deviation were used for descriptive analysis. T test was used for comparing the means of quantitative variables; whereas, chi- square test was used for qualitative variables. Logistic regression analysis was used for precise evaluation of the correlation between spirometric parameters and exposure to dust particles. In all statistical tests the confidence interval (CI) was 95% and p<0.05 was considered as significant.

## RESULTS

This study evaluated 411 personnel working in a tile and ceramic factory out of which 243 (59.1%) were working in the production units and comprised the study group and 168 (40.9%) were executive employees of the factory and were considered as the control group. The mean age was 36.94 yrs (range 21-64 yrs), the mean duration of employment was 7.60 yrs (range 1-15 yrs), the mean height was 172.12 cm (range 147-190 cm) and the mean weight was 74.45 kg (range 41-121 kg). There were 128 smokers (31%) and 283 nonsmokers (69%).

Table 2 compares the demographic variables between the 2 groups of study and controls. There was no significant difference in the mean age,

duration of employment, the mean height, the mean weight, or smoking habits between the 2 groups (p>0.1). Sixty seven (27.5%) workers in the study group and 30 (17.8%) controls had respiratory complaints. By using chi square test, it was revealed that the frequency of respiratory complaints was significantly higher in the study group (p=0.023, OR=1.751, 95% CI=1.078-2.844). Table 3 compares the frequency of respiratory complaints between the 2 groups. As shown in this table, the prevalence of all respiratory complaints (dyspnea, cough, sputum, wheezing, dyspnea at work) was significantly higher in the study group. The frequency of respiratory complaints was 28.12% (36 subjects) in the smoking group and 21.55% (61 subjects) in the nonsmoking group (P>0.05). Three-hundred sixty-two (88.1%) subjects had normal and 49 subjects (11.9%) had abnormal spirometric findings. Eight (4.7%) subjects in the control group and 41 subjects (16.8%) in the study group had abnormal spirometric findings. The frequency of abnormal pulmonary function test was significantly higher in the study group (P<0.001, OR= 4.059, 95% CI= 1.851-8.904). In the study group, 24 subjects (9.8%) had obstructive and 17 subjects (6.9%) had restrictive patterns. Among the controls, 4 (2.35%) had obstructive and 4 (2.35%) had restrictive patterns. The mean of spirometric parameters was significantly lower in the study group (P<0.05, Table 4).

Table 2. Comparison of related variables between case and control groups.

Variable	Exposed group	Unexposed group	p-value
	Mean ± SD	Mean ± SD	
Age (year)	36.85±7.71	37.07±7.60	0.78
Duration of work (year)	7.63±2.96	7.57±2.54	0.82
Height (cm)	172.37±6.49	171.77±7.28	0.38
Weight (kg)	74.95±13.47	73.73±11.79	0.34
Smoking (pack-year)	3.25±5.79	2.59±4.45	0.21

**Table 3.** Prevalence of respiratory symptoms in exposed and unexposed groups.

Symptom	Exposed group	Unexposed group	P-value
	(n=243)	(n=168)	
	N (%)	N(%)	
Dyspnea	32 (13.1)	10(5.9)	<0.001
Shortness of breath at work	21 (8.6)	-	<0.001
Cough	20 (8.2)	11(6.5)	<0.05
Wheeze	11(4.5)	4(2.3)	<0.05
Sputum	25(10.2)	9(5.3)	<0.05

**Table 4.** Mean values of spirometric parameters in exposed and unexposed groups.

Parameter	Exposed workers	Unexposed workers	P-value
	Mean ± SD	Mean ± SD	
FEV <sub>1</sub> (%)	87.17±11.80	92.03±12.34	<0.001
FVC (%)	88.07±11.44	92.10±12.52	<0.001
FEV <sub>1</sub> /FVC (%)	91.75±6.46	97.56±5.63	<0.05
FEF <sub>25-75%</sub> (%)	82.79±12.40	86.82±20.79	<0.05
PEF (%)	80.08±17.45	83.85±20.36	<0.05

Logistic regression analysis was used for precise evaluation of the correlation between abnormal spirometric findings and exposure to dust particles in the factory (Table 5).

**Table 5.** Relationship of spirometric abnormality with variables of age and exposure to dust using logistic regression analysis

Variable	B	S.E	OR	95% CI	P-Value
Age	1.83	0.34	6.27	3.16-12.43	<0.001
Exposure to dust*	1.27	0.41	3.57	1.58-8.05	<0.05

\* Unexposed group as the baseline

The results showed that even after adjustment for confounding factors, a significant correlation existed between the abnormal spirometric findings and exposure to dust particles ( $p<0.05$ ). Also, a significant correlation was found between age and abnormal spirometric findings ( $p<0.001$ ). However, the correlation between abnormal spirometric

findings and duration of employment or smoking habits was not significant ( $p>0.05$ ).

## DISCUSSION

In this study respiratory disorders were detected in workers of tile and ceramic factory in the form of respiratory complaints and abnormal pulmonary function tests. In our study, no significant difference was detected between the 2 groups in terms of the mean age, duration of employment, weight, height, and smoking habits. Therefore, the correlation between exposure to dust particles in the factory and respiratory disorders in workers was not affected by the confounding factors and was statistically significant. In this study, we noticed increased prevalence of respiratory complaints like cough, sputum, wheezing and dyspnea among production unit workers compared to executive employees and this difference was statistically significant. A study by Halvani and colleagues in 2006 conducted in a tile and ceramic factory showed that respiratory complaints in the study group was significantly higher than the control group (9).

Bahrami and colleagues in their study on ceramic workers in 2003 demonstrated increased prevalence of respiratory complaints among the exposed group. However, this increase was not statistically significant (23). Increased respiratory complaints in workers exposed to ceramic dust was also noticed by Neghab et al. (16). Also, Trethowan et al. in their study on workers of 7 ceramic factories located in 3 European countries found significantly increased prevalence of respiratory complaints among ceramic workers (24).

In our study, the spirometric parameters were significantly lower in the production unit workers compared to executive employees. These results were in accord with those of Myers et al. study on 268 brick workers reporting a decrease in FEV<sub>1</sub> and FVC (25).

Halvani et al. showed decreased spirometric parameters among exposed workers but this decrease was not statistically significant (9). In 2005, a study was conducted by Sakar and his colleagues on ceramic workers which showed reduced spirometric indices in exposed workers but this decrease was not significant either (26). A significant decrease in FEV1 and FVC of exposed workers was noticed by Neghab et al. in their study but no decrease was detected in PEF,  $\frac{FEV_1}{FVC}$  (16).

A decrease in spirometric parameters of workers exposed to tile and ceramic dust particles has been well documented in several previous studies as well (12,14,17,27). However, Bahrami et al in their study in a ceramic factory did not show a significant decrease in spirometric indices of exposed workers in comparison with controls (23). In our study, a significant correlation was found between aging and abnormal pulmonary function test which was in accord with the results of Neukirch and coworkers (28). Our study showed increased frequency of respiratory complaints among smokers but this increase was not statistically significant and this finding was in accord with that of Halvani et al (9). However, the insignificance of this increase in our study might be due to the low number of cigarettes smoked by the smokers (the mean cigarette consumption was 2.92 packs/year).

In our study, a significant correlation was found between exposure to tile and ceramic dust particles and abnormal spirometric findings even after matching for age, duration of employment, and smoking habits.

## CONCLUSION

Our study showed a significant correlation between occupational exposure to tile and ceramic dust, decreased spirometric parameters and increased frequency of respiratory complaints. Dust concentration should be reduced to safe levels in

these factories by enforcing the control methods like using local ventilators and a humidity system to decrease the amount of dust particles floating in the air. Appropriate personal protection equipment should be used by the workers and a comprehensive respiratory protection program should be implemented. On the other hand, using a proper respiratory questionnaire and performing pulmonary function tests in periodic examination and screening programs for workers can efficiently prevent the development of respiratory diseases in them.

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